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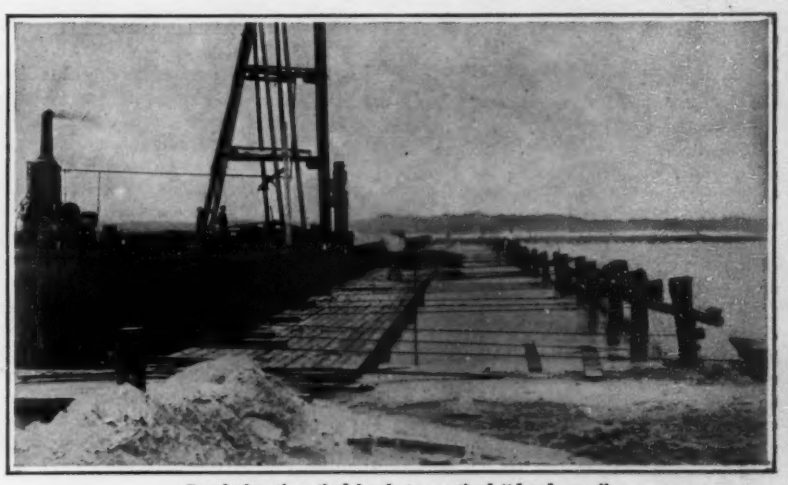
Complete bulkhead before concrete coping was placed



Steel sheeting tied back to vertical "dead men"

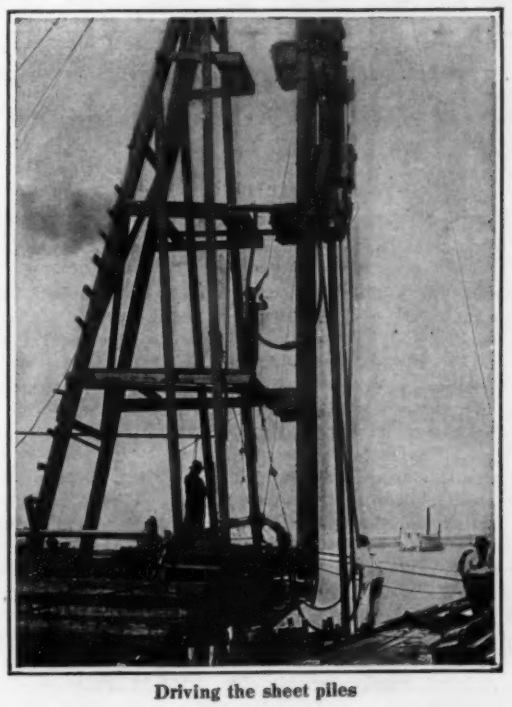
New Methods in Bulkhead Construction

AT Jacksonville, Fla., the St. John's River turns abruptly north, making an angle of 90 degrees or less, with the city in the vertex. The angular piece of land is known as Commodore Point. The center of the shipping district is perhaps one and one-half miles up the river to the east. For a long time the location has seemed to be an advantageous site for the extension of the docking facilities of the city. Political contentions centered upon the property. At one time, it was proposed as the site for municipal docks; eventually, however, private interests took hold. These have created an extensive wharf, developing not only the land above water but adding to it by building up from the bottom of the river. Ultimately, the development is to comprise 132 acres. Of this acreage, about seventy-five acres is natural land, while the remainder, 57 acres, belongs to the shallow water adjoining the shore. The portion of the site rated as land was a marsh and lay only about a yard above mean low tide at its maximum elevation. At the flood of ordinary tides pretty much the whole site of the development was submerged. But now there is an extensive area with its surface above all tides and with a very considerable wharf frontage.

Wood is unsuited for submerged construction at Jacksonville because of the presence and activities of the teredo. A wooden wharf would probably have been the economical thing had it not been for this consideration. A suitable concrete bulkhead wall of the usual heavy type would have cost too much. What has been done is to strike in between the two extremes. Wood has been used but it is wood enveloped by soil and in consequence free from the depredations of the teredo. Concrete is used also; but the amount is cut down to a comparatively small yardage by the use of suitably distributed steel members.

The rock immediately underlying the soil is about thirty feet below mean low tide. In order to investigate conditions bore holes were put down along two lines 15 feet apart. The intervals between consecutive holes were 25 feet in length. These exploratory borings disclosed coral rock for the greater part of the frontage. At or near one end, however, clay was found instead of rock. The rock was overlaid by a stratum of sand which varied in thickness from two to forty feet.

The method of combining steel and concrete at this waterfront is probably without previous example. It should be borne in mind that economy largely controlled the situation. At the same time, the potentialities of this combination have been actually demonstrated. It is possible, naturally, that the next similar combination will disclose some technical advances in respect to details. Since wood was at the outset left out of the question for exposed construction, concrete or other masonry was indicated as the proper thing for the construction of the bulkhead wall. Thus, great concrete blocks, such as those in common use in New York Harbor, might have been built into a wall. Such a wall would, however, if constructed after the usual manner, have required a very great thickness because of the great depth and weight of the filling to be put behind it. As the frontage was about a mile in length, too great expense would have been entailed. An alternative would have been to employ reinforced concrete cellular cribs, such as lately have found use in Canada. The cribs would have been sunk along with a filling, say, of rock. Or, the concrete cribs might have had a simple box-like form, such as those used on the Pacific Coast of North America. But all this kind of construction runs into money, partly because of the cost of the actual materials and partly because of construction expense. Wooden cribs filled with rock would have been splendid, no doubt, had the teredo not been in possession.



Driving the sheet piles

What a single sheet pile looks like

It seemed necessary at Jacksonville to adopt a method less expensive than those represented by the foregoing suggestions. The type of bulkhead wall that has been adopted is perhaps without precedent, especially if one takes into account the size of the wall and the severity of the conditions.

Wood if perpetually submerged is a most excellent material, having an indefinite life. This has repeatedly been proved at New York and elsewhere when old piling has been pulled and found upon examination to be in just about as good condition as when put down. So, if it had not been for the teredo, wooden cribbing would have been quite proper, up to a point, say, one foot below low water level.

Steel would seem to have a long life under the same conditions as wood; but the matter hardly rests on equal evidence. Corrosion seems to require the combination of free oxygen—as the oxygen in the air—and moisture. Water contains more or less air in the form of minute bubbles; but this condition probably ceases to a large extent at a distance below the surface. Further, the total amount of oxygen in such bubbles is small, this gas being diluted with four times as much nitrogen. The use of steel would then appear to have been within the possibilities at Jacksonville, particularly if protected.

At any rate, steel has been called into service on this job and used in two ways. First, steel sheet piling has been employed to provide a continuous diaphragm extending along the whole length and reaching down into the underlying rock at the bottom. Necessarily, such sheeting consists of narrow vertical strips. But these are, for the most part, interlocked, each and every one with its neighbors along the frontage. There are exceptions at points where the wharf rounds the 90-degree curve and perhaps at other points where pieces

(Concluded on page 200)

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

The Rôle of the Airplane Mechanic

IF our aerial preparations are to be crowned with success, it is imperative that we secure an army of skilled, conscientious airplane mechanics. For after pilots, an air fleet requires a well-organized non-flying personnel to groom the winged steeds which carry aloft the knights of the skies.

An airplane is indeed a fragile thing, no matter how strong it may appear. It is made of wood, light metal, linen—all delicate materials, and driven by an engine in which every ounce of metal that could possibly be spared has been removed. So it is obvious that such a vehicle requires constant attention and adjustments and repairs. Every time a machine returns from a flight it must be carefully examined; guy wires must be tightened; bolts must be made firm; and any rents in the vast spread of taut linen must be mended. The engine must be overhauled after some seventy hours of constant service, and that in itself is quite an undertaking.

But careful inspection and overhauling preclude accidents in the air. The pilot, starting out for the day's work, must needs place full confidence in his mechanics. He must feel at ease as regards the condition of his machine; otherwise he cannot perform his duties to the best of his ability. And to realize this condition of confidence an airplane cannot receive too much grooming.

At present it is understood that our flying service is having some difficulty in securing airplane mechanics. The trouble lies not in lack of numbers, but rather in the type of men enlisting for this service; for the requirements of this work are exceedingly peculiar, and a non-flying personnel is a matter of much training in actual airplane inspection and repairs. The experience and training of the automobile repair man, we are told, is valuable, especially on the engine end; but when it comes to repairs on the fragile airplane proper, his type of handiwork is somewhat too heavy. Here is where the skilled woodworker or cabinetmaker can best serve his country. Again, in the matter of adjustments, where guy wires must be pulled taut to a nicety, perhaps the trained mechanic is best prepared for the task. Lastly, the repairing of wings with glue-pot and linen calls for still another class of artisan, possibly a piano builder who has been doing delicate gluing on piano-action parts for years. At any rate, this all goes to prove that the airplane mechanic must come from all classes of peace-time occupations, or he must be exceedingly versatile.

It is to be hoped that all men who have the requisite training will endeavor to enlist in the non-flying service of our aerial forces. For with wrench and pliers and blow-torch and glue-pot, they too will help win the war

Enemy Property

WHEN Congress last October, in passing the Trading with the Enemy Act, made provision for taking over enemy property in the United States, and so administering it that its income may be turned into the purchase of bonds to help prosecute the war against Germany, few people realized the magnitude of the undertaking involved. When the Alien Property Custodian began to get his office into shape, so much room was required and so little was available in the government buildings that it was necessary to take over and occupy an apartment house in one of the residence districts of Washington. After the force was installed it was found that the building was too far from the business section to enable the employees to get their lunches, so a complete restaurant had to be installed and operated to feed the several hundred men and women at noon time.

The Alien Property Custodian is really running a huge trust company, utilizing the services of hundreds of experienced bank and trust company employees, lawyers, trained investigators, and stenographers. The work of this big organization is divided into five main bureaus—administration, investigation, legal, trust and audit. The custodian is assisted by a managing director, five bureau directors, and chiefs of the various divisions and sections. Each day there is a meeting of these division and bureau chiefs for conference, just like a board meeting of a great corporation. This greatest of all trust companies manages a long list of enterprises, little and big, including everything from railroads to orphans' estates—with breweries, lumber camps, candy factories, insurance companies, theaters, moving-picture houses, art galleries and steamship companies making up a few of the items.

Not the least of the Alien Property Custodian's functions is that of locating the property which he is to administer. First of all comes the question, Who is an enemy? In general this is answered on the basis of residence. A German citizen who peacefully resides in this country, who obeys the law, and who does not engage in correspondence or trading with persons within the enemy's lines, or in pernicious activities within the United States, escapes any interference with his property. But anyone living within the boundaries of Austria, Germany, Bulgaria or Turkey or within any territory now occupied by the military forces of these nations is an alien enemy, at least presumptively. Even an American citizen in Germany may be an enemy under the act. American heiresses who have married German husbands thus have their incomes from the United States cut off.

The law requires all trustees or custodians or agents for enemy property in this country to report it to the Alien Property Custodian, under heavy penalty; and all large holdings are presumably reported, since they would be comparatively easy to locate and identify. But the small holdings, large in the aggregate, are the ones that present difficulty. Enemy property is not merely real estate, life insurance, railroads, mines, stocks, or bonds. It may be a partnership in which persons residing in the Teutonic territories are interested. It may be a debt owed to a German or an ally of Germany by an American citizen or corporation. A woman in Georgia forwarded 72 cents which she said she owed a friend in Germany, and some one in Hoboken turned in the little tin banks in which collections were being made for the benefit of German war widows and orphans. After the war these pennies will reach their intended destination; until then they must help Uncle Sam fight.

The difficult task of locating all these small holdings is one in which the Custodian needs the assistance of every American citizen. Every reader of this magazine can render a real service to the government by reporting direct to the Alien Property Custodian in Washington any alien enemy-owned property of which he or she knows. Such information will be treated as confidential and respected as such. We cannot urge our readers too strongly to fall in with this recommendation in every case where they happen to be able to do so.

Why the Inventor Invents

ONE idea a week is the average for an inventor of our acquaintance. By vocation the man is an engineer and general handyman in a large New York club, but by avocation he is an inventor, a born inventor—if inventors are really born. And his ideas are not limited to one field or to one line of reasoning, for one week it may be a non-skid automobile device, the next a new propeller design, then a fascinating game, followed by a dustless ash sifter, and so on from one thing to something totally different. Which makes his case all the more remarkable.

All about us there are hundreds and thousands of inventors who at some time or another have brought forth a good idea or perhaps two or three ideas. But when a man can conceive of one good idea a week and keep up this rate for a year or two, he is certainly the high priest of the inventors' cult. So we recently inquired of him how he came to think up so many ingenious ideas in so many dissimilar fields. And this is what we learned:

Inventions are generally due either to accident or to careful study. Many of the leading inventions can be traced to a chance remark, accident or peculiar incident; indeed, there is a wealth of romance in the history of many inventions. But what makes for inventions as nothing else can, is to refuse to accede the perfection of any given thing. No matter how good it is; no matter how apparent seems its perfection; no matter how long it may have existed in its present shape—it can and it must be improved upon. This makes for progress.

We know of another inventor who refused to consider the violin as a perfected instrument, despite the fact that it has not changed its form in the past three hundred years or more. Not long ago he brought out a new type of violin which met with instant success. Another inventor believed shoes were far from perfect. Why shouldn't they be ventilated? Doctors tell us that lack of air accounts for most foot troubles. Why not let the feet breathe? thought this inventor; and he went to work and finally perfected a simple shoe ventilator. And so we could go on with specific instances of improvements which have been made on "perfect" articles.

The true inventor takes nothing for granted. Perfection, to his way of thinking, is strictly a comparative term. He makes "perfect" things still more perfect. Hence his success.

The Sense of Smell in Insects

IT is a matter of common knowledge that the smelling power of mankind is but feebly developed in comparison with that of certain members of the brute creation, and the proverbial best smeller is the dog. In this case, however, as in so many others, the proverb has fallen far behind the van of scientific investigation. As the nose of the man is to the nose of the hound, so the nose of the hound is to the smelling organs of various insects. The insect's "outlook" upon the world appears to be preëminently through the olfactory sense, just as ours is preëminently through the eyes, and the respective senses are quite comparable with each other in their powers. Thus it is recorded that a male moth can "smell out" the only female in the neighborhood at a distance of a mile. In the case of ants it has been suggested that the movable antennae, which bear the organs of smell, give these insects an olfactory space perception not unlike the optical and tactual space perception of man.

A storehouse of fascinating information concerning the rôle which smells play in insect life is laid open to us by Dr. N. E. McIndoo's monograph, "Recognition Among Insects," just published by the Smithsonian Institution. This work is based to a large extent upon the author's remarkable studies of bees. There is abundant evidence that smell is the chief means of recognition among these insects. In order to approach this subject through facts already familiar to human experience, we should remember that even our degenerate noses are able to distinguish a horse from a cow, a goat from a roe, and a dog from a cat. With practice we can accomplish greater feats. Dr. McIndoo was able, at the beginning of his work with bees, to distinguish only the more pronounced odors—the hive odor, brood odor, honey odor and wax odor. At the end of one summer, however, he could distinguish the three castes of bees—workers, drones and queens—merely by smelling them, and had even learned to recognize some subordinate scents in connection with these groups. Old workers for example, besides possessing the characteristic bee odor, emit, when seized, another distinct odor, which comes from the poison ejected through the sting. A worker carrying pollen also gives off an odor due to the pollen. The younger the workers, the less pronounced is the bee odor emitted. To the human nose the odor emitted by nurse bees and wax generators is much less pronounced than is the odor from old workers. When newly emerged from their cells, workers have a faint sweetish odor, but lack the characteristic bee odor. Old queens have a strong sweetish odor, while young queens just out of their cells, have a much fainter odor. The majority of old drones have a faint odor, while almost every young drone has a stronger odor, slightly different from that of young workers and less sweetish.

The fact that the trained human nose is able to distinguish these differences makes it easy to credit the assertion that many finer shades of odor are perceptible to the bees themselves and play an important part in their relations to one another. Dr. McIndoo quotes Buttel-Reepen's enumeration of the smells of the honey-bee, as follows: 1. The individual odor. 2. The family odor, common to the offspring of one queen. 3. The brood and chyle odor. 4. The drone odor. 5. The wax odor, differing for different colonies. 6. The honey odor, distinct for each colony. If a queen be daubed with honey from a queenless colony, she will be readily accepted by that colony when inserted. 7. The hive or colony odor, normally a mixture of the preceding odors, or some of them. An abnormal hive odor may arise under conditions of disease, etc.

The author describes a long series of experiments by means of which he has shown the reality of these and other scents in honey bees, and points out how they affect the life of the hive. The subject has many applications in practical bee-keeping. For instance, the success attained in uniting bees from two or more colonies depends upon the formation of a new hive odor. In order to have peace among the members of the new colony the original hive odors and individual odors must be thoroughly mixed. The addition of smoke helps in this process. The hive odor serves as the sign or badge by which all the members of a colony know one another, and a foreign hive odor promptly provokes hostilities among workers. Worker bees returning to the hives from the field pass the guards unmolested because they carry the proper sign.

All insects apparently emit odors, but only those of honey-bees and ants have been carefully studied. In ants the family odor seems to play a much more important rôle than it does in bees, where the hive odor has become the principal scent. Concerning the scent-producing organs of insects an abundance of information is available, and this is quite fully summarized in the memoir under discussion.

Electricity

Buying Heat in the Form of Steel Rods.—To an American manufacturer belongs the credit for standardising electric heating; at least, he has brought out heating units in the shape of thin steel rods containing the resistance wire. These rods are made in various capacities and for various voltages, and it is planned to carry them in stock in all electrical supply stores. Thus any part of a home, store, warehouse, or factory can be heated by one or more of the new units at a trifling expense.

A Nitrogen Radiator.—A recent addition to electric heating appliances is a radiator filled with nitrogen gas. It maintains an average temperature of 350 degrees Fahr. The electric heating element of this radiator is surrounded by nitrogen gas which fills the entire inside of the radiator. Obviously, the latter is hermetically sealed. The gas serves to carry the heat from the heating element to the radiating surfaces at a temperature higher than that of a steam radiator. One feature pointed out for this device is that there is no way by which clothing, drapery or anything else can catch fire, as it has no exposed red-hot open wires.

Maintaining an Even Temperature Electrically.—There is now being offered an automatic controller that regulates the amount of current delivered to any heating appliance and maintains the heat of the appliance at an even temperature. This device is made in two types, one for alternating current and the other for direct current. In principle, the device is merely a thermostat: it contains a bimetallic strip of copper and iron riveted together, which is placed immediately over a heating coil and connected in series with the load. The heat developed by the coil causes the thermostat to break the circuit whenever the temperature rises above a certain point. A handle on the outside permits the device to be set for any temperature between 90 and 160 degrees.

Searchlight Ranges.—In an article in the *Electrical World*, Lieut. S. G. Hibben gives some particulars of the range of electric searchlights. In general, owing to atmospheric absorption, it is impracticable to work at ranges exceeding 6,000 yards, although cases are on record in which ships have been distinguished at a distance of nine miles, and on slightly misty nights the glare of distant beams may be seen in the sky at even greater distances. With a 60-inch mirror, an arc operating at 20,000 watts, the ranges at which targets of gray and medium light targets may be satisfactorily illuminated are stated to be as follows:

Very clear atmospheres	10,000 yards (or more)
Average atmospheres	6,000 yards to 8,000 yards
Slight haze or rain	3,000 yards to 4,000 yards
Fog or early dawn	1,000 yards to 2,000 yards

A Machine which Taps Live Wire Circuits.—Out in Redlands, Cal., H. B. Bush has developed a remarkable tapping machine which enables anyone to wrap a tap wire around a live wire without danger to himself. In describing this apparatus, a contemporary states that piece of ordinary No. 6 or No. 8 B. & S. gage bare annealed copper wire of approximately the right length is selected to make the tap. One end of the tap wire is wrapped upon the end of the dead branch line by hand, and the machine is then set on the tap wire at a point that will leave three inches or four inches of slack. The excess length of tap wire is then cut off, leaving six inches or eight inches sticking out through the machine. The machine is then moved up and on to the main live wire and the crank is turned to the right. This rotary motion is transferred to the winding head through a set of bevel and spur gears. The winding head rotates around the main wire as an axis, and this motion wraps the tap wire around the main line wire and also pulls all slack out of the tap wire. On the end of the wrap a close pigtail is wound. After all the tap wire has been pulled through the winding head, the direction of the crank is reversed, the machine unhooks itself from the main line and the tap is made.

Charged Barbed Wire Entanglements.—Recent despatches from our fighting front in France convey the interesting information that the Hun has resorted to the old stunt of passing a powerful electric current through his barbed-wire belts. During a night raid not so long ago, our boys, after penetrating the enemy's first barrier and when near the second, were startled by a soft, crackling sound coming from the belt back of them. They turned in time to see the wires illuminating with a faint purplish glow, with here and there a vicious spark leaping into the air. The wires were charged. We are told that after a while the electrical demonstration ceased, and our boys returned to their trenches. Fortunately, the current was sufficiently powerful to cause a corona discharge, or purplish glow; otherwise, and without warning, our soldiers might have come in contact with the charged wires with perhaps fatal results. Inasmuch as this ruse is forever appearing here and there on all battlefronts, it might be well for raiders to carry some simple form of instrument which would indicate charged wires. As a general thing, of course, the current flowing through the barbed wire betrays itself through arcs or sparks. But again, it may not!

Science

The Samoa Observatory, at Apia, which has been maintained for the last 15 years by the Royal Society of Sciences of Göttingen, is probably the most important meteorological, seismological and magnetic outpost in the South Pacific. It is extremely gratifying to learn that Dr. Angenheister, the German director, has been permitted by the New Zealand military authorities to continue the work of this observatory and send out scientific communications.

Rice Culture and Malaria.—It has been found that the culture of rice in the United States, as in other countries where the matter has been investigated, is attended by the production of enormous numbers of Anopheles mosquitoes, but to what extent the prevalence of malaria is influenced thereby has not yet been accurately determined. A study of this question is being carried on at Crowley and Lake Charles, La., by the U. S. Public Health Service.

Polish Technologists Meet in Moscow.—The American consul general at Moscow reports that Polish engineers and technicians residing in Russia held a congress in that city last October, with an attendance of 285. Plans were discussed for the rehabilitation and development of industry in Poland after the war and the organization of technical education. There were sections of the congress on architecture, mechanics, chemistry, electricity and economics. An association of Polish engineers and technicians is to be formed in Russia, with branches in the principal industrial centers, and it will publish a bi-weekly journal.

A National Plant Disease Survey.—The U. S. Bureau of Plant Industry has recently organized a new office known as the Plant Disease Survey, under the direction of G. R. Lyman. Its principal objects are to collect information on plant diseases in the United States, covering such topics as prevalence, geographic distribution, severity, etc., and to make this information immediately available to all persons interested, especially to those concerned with disease control. Collaborators have been appointed in every state, and, in addition, special investigations will be carried on to collect data on diseases of particular importance. During the crop season the survey publishes, at frequent intervals, a bulletin summarizing all the important information obtained.

Humogen.—Dr. E. J. Russell has published in the *Journal* of the Board of Agriculture (London) a review of the experimental work that has been done to test the alleged merits of "humogen" (bacterized peat), at Rothamsted and elsewhere. He finds no evidence that humogen possesses any special agricultural value. The claim has been repeatedly made that it is "50 times as effective as farmyard manure," but the experiments indicate that it is actually no better than any other organic manure with the same content of nitrogen, and that there is no justification for the high prices asked for it. The material varies widely in composition and in fertilizing value. The author concludes that "there is no definite evidence that 'bacterization' really adds to the value of peat."

Solar-Constant Observations in South America.—The Astrophysical Observatory of the Smithsonian Institution has not yet been able to carry out its plan of establishing a station for solar-constant work in South America, although an appropriate site has been found, with a record of 300 cloudless mornings per annum for observing. The equipment for this station was all prepared and packed, when conditions arising from the war made it necessary to postpone the undertaking. The expedition was accordingly sent, temporarily, to Hump Mountain, North Carolina, a station at 4,800 feet elevation and ordinarily favored with clear skies, though it is stated that the weather during 1917 was the cloudiest and rainiest heretofore known in that region. The preparation of equipment for this station led to valuable improvements in the bolometer and the pyranometer, and to the invention of a new instrument for avoiding computation in reducing spectrobolometric observations.

Counting Blood Corpuscles.—The Franklin Institute has recently awarded its Edward Longstreth Medal of Merit to Mr. Max Levy, of Philadelphia, Pa., for his new form of Haemocytometer. The purpose of this device is to provide an improvement in chambers for counting blood corpuscles. The specific improvement is in forming the entire chamber, with the exception of the cover glass, from a single plate of glass. Cross lines, one-twentieth of a millimeter apart, are ruled upon the glass base, thus dividing the surface into squares one four-hundredth of a square millimeter in area. The surface upon which these rulings are made is one-tenth of a millimeter below the under surface of the cover glass through which the blood corpuscles are counted with the aid of a microscope. The channels in this hæmocytometer run across the slide, making it much easier to clean than the disk form. A modification has the rulings made on a separate plate, cemented into a transverse groove cut in the base plate, into which it is accurately fitted. The instrument is a decided improvement over those heretofore obtained from Germany.

Automobile

Pneumatic Tires in Europe.—It is stated that pneumatic tires have practically disappeared in Germany where casings, such as have survived, are filled with compressed corks, rags, paper and packages of ground cork, while many cars run on their rims, wrapped with rope. In Holland tires are said to cost $350, while in England and France they sell for $90.

A New Detachable Wheel.—Many ingenious designs for detachable wheels have been introduced, but an English inventor has recently brought out a new one which he claims can be removed in four seconds, after the wheel has been jacked up. Such quick work would undoubtedly necessitate some slight of hand, but the drawings of the locking device indicate that the operation can be performed as easily and as quickly as anyone could desire.

Rapid Changing Method for Spark Plugs.—In a recent French method, the spark plugs are mounted in a holder which is designed so as to slide along the cylinder of the engine and thus bring any one of the plugs into the working position. Sliding of this piece or holder brings the spark plug in question into a position in which it comes against a spring piece which serves to make contact for the plug with the main circuit. At the same time, the plug comes opposite a hole in the side of the cylinder, and this allows of igniting the gas by means of the spark. By this device, should a spark plug give out, it can be at once replaced by another.

Benzole as a Fuel.—With gasoline at 95 cents a gallon in England it is natural that substitutes should be diligently sought and studied. Considerable attention has been given to benzole, although that fluid is not at present available as the entire output is required for munitions purposes. Most experimenters recommend a mixture of half benzole and half gasoline; and with this it has been found that, owing to absence of knocking, the ignition can be kept considerably more advanced than with gasoline alone. As a result the throttle can be opened more rapidly, so that after a slow-down the car will pick up speed much quicker, and more smoothly. Slow pulling is also improved, and a car that knocks habitually with gasoline will run perfectly on the mixture of equal parts of gasoline and benzole.

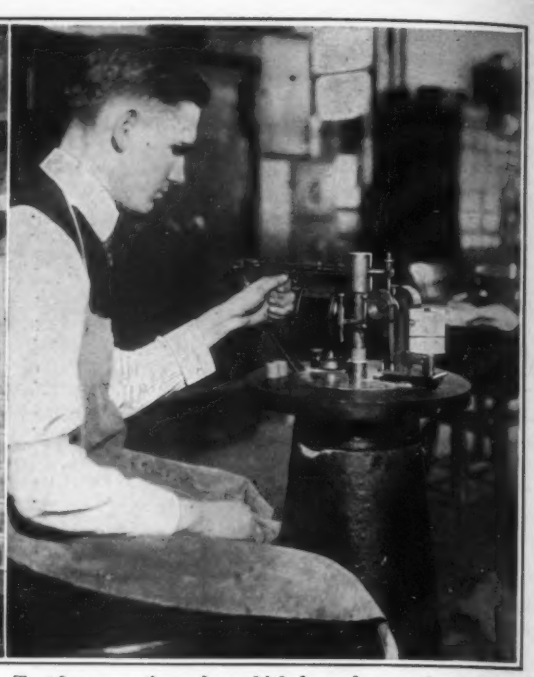
Motor Cars for Malay States.—There seems to be a very good field for automobiles of various classes in the Federated Malay States. Most of those imported come from the United States or Great Britain. In spite of the war, this country is in a prosperous condition because of its resources in tin and rubber. Planters and miners use motor cars and cycles, but the principal business is probably done with the wealthier Chinese, who are not content in many cases with only one car when once they take to motoring. There may also be a great future for motor traction, for although the railway system is an excellent one and serves all the most populous districts, there are new tracts of country being opened up which may have to depend for some years upon other methods of transport.

Gear Ratios.—While we are usually overwhelmed by the mass of information in automobile catalogues there is one item that is conspicuous for its absence, and that is the gear ratio of the drive. There may be two explanations for this reticence. In the universal desire to make a good showing of hill climbing on "high" there is a great temptation to make that high gear in reality a very low one, which would not be conducive to the most satisfactory operation on smooth, level roads. Then again, on account of the difficulty so many people have in making a gear shift, especially on hills (owing to the crudity of gear shift design generally), if the ordinary running gear is made low enough, the driver is not called upon to shift gears very frequently. When we get a gear shift that is as easy and as simple to operate as the spark advance many things will be changed.

Conserving Inner Tubes.—Considering the abuse to which inner tubes are subjected by the ordinary automobile owner it is a wonder they stand up as they do; but the increasing cost of rubber will undoubtedly compel more careful methods of handling. Taking a single point in tire manipulation: How many people properly talc a tube when putting it into a tire? Many do not even provide themselves with this necessary material. The constant movement between the casing and the tube causes a friction that is destructive to the tube. Moreover, this friction, and that resulting from the constant flexing of the casing, heats the tire, causing the tube to stick to the casing, with the result that the tube is torn. To overcome this friction a liberal quantity of talc, powdered soapstone or graphite should be rubbed over the tube when it is put into the casing to act as a lubricant between the casing and the tube. Care should be taken, however, not to put too much of the powder into the casing, as is frequently done, for the loose excess collects into hard lumps that are apt to grind a hole through the delicate tube.

Testing the strength of cement by measuring the pull necessary to tear it apart

Mechanical analysis of sand; the percentage retained on each of a graded series of sieves is determined



Test for cementing value, which depends upon the number of blows necessary to break down the briquette

Extracting Stories from Stones

Road Building Reduced to a Science

"WHAT kind of a road shall we build? Macadam? Water bound? Tar or oil bound? Gravel, sand-clay, earth? Shall we build with the rock we have at hand or import rock from somewhere else? Will the rock that is here, which costs nothing to transport, make a road which will wear?"

These and kindred questions should be asked by any community which has voted money to build roads. They should be asked by any individual who is going to build a driveway to a country home. They should be asked by any one, anywhere, who has anything to do with the selection of the type of road to be built, and the materials with which to build it.

Of course, the layman cannot answer them. But Uncle Sam can—he maintains a special road materials testing laboratory in the Office of Public Roads, Department of Agriculture, Washington, D. C., for the express purpose of answering such questions. More than that, he, through his learned road builders, has devised and built special testing apparatus and machinery, by means of which samples of rock and other road building material are made to tell their story—tell it so well and so completely that, once the test is finished, those who are to make roads know to a certainty just what they can expect of the material, just how it will wear, just what value it has as a foundation or surfacing material.

Not very long ago the general idea of a road was a smooth way, which, once built, was an integral part of the landscape, as immovable as a mountain and about as apt to wear out. Today almost every one knows a road as a tool, a means to an end, an economic investment which must be carefully planned, as honestly built and as rigorously maintained as any other tool of commerce—as any railroad, factory, mine, well or other source of wealth.

Early roads were mere paths in the dirt, sometimes with, sometimes without, rock sprinkled upon them. Modern roads are built as a house is built, with proper foundation, drainage, roof and walls, and must be maintained as a house is maintained, repairs made as the first break comes, lest the whole investment crumble.

That the repairs and maintenance be as little as possible, that the returns on the investment be as great as possible, it is highly essential that the right material go to the right place.

To this end does the testing laboratory labor.

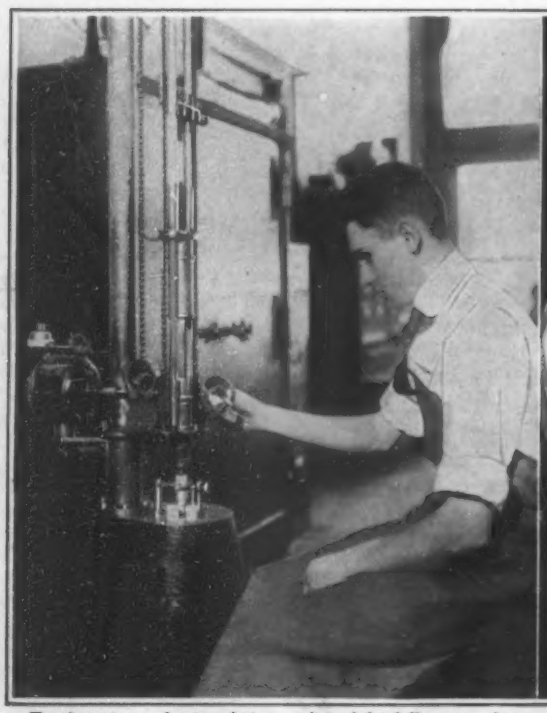
The important characteristics of rock used for road making are hardness, toughness and sometimes cementing value or binding power. Other features of rock are of interest to road engineers, such as the amount of water a given kind of rock absorbs, its specific gravity, its weight per cubic foot, its resistance to compression, etc., but the three essentials are as stated.

To determine these qualities of rock many dainty and delicate machines are employed, and some of more vigorous construction such as the Deval abrasion machine. In this machine cast iron cylinders are mounted on a shaft so that the axis of the cylinders is inclined at a 30-degree angle with the axis of rotation. The material to be tested is broken up into pieces of which not more than sixty or less than forty, the lot weighing 11 pounds when thoroughly dried, are placed in each cylinder. Care is used to see that the pieces have sharp freshly broken and not rounded edges which greatly affect the accuracy of the result. The exact weight having been ascertained, the cover is bolted on the cylinder and the machine is started. It revolves at the rate of 30 turns a minute and 10,000 revolutions make a test. The tested rock is then carefully screened through sixteenth-inch mesh, the remaining material washed and dried and weighed. The difference between the initial and final weight shows the loss by abrasion.

As the sample is thrown twice the length of the cylinder in each revolution the individual stones grind against each other, as well as against the sides of the cylinder. The rock may be broken by impact, so the test is not only for hardness but for toughness. Values of the per cent of wear run from as low as one in rare cases to as high as 30 or even 40 for some sandstones and limestones.

A rock may be very hard indeed, and suffer little from friction, and yet break under impact without much difficulty. So special hardness and toughness tests in addition to the abrasion test are conducted.

For these tests specimens of rock of definite size must be obtained. The method is to drill a round core of rock from a specimen, using a diamond core drill in which the cutting is done with specially mounted black diamonds on the lower edge of the tube doing the cutting. The core of rock thus obtained is faced off to the proper dimensions with a diamond edge rock saw, both pieces of apparatus being delicate and designed expressly for this work. For the hardness test, the core, which is about one inch in diameter and about three inches in length, and which



Testing stones for toughness. A weight falls upon the little cylinder until fracture occurs

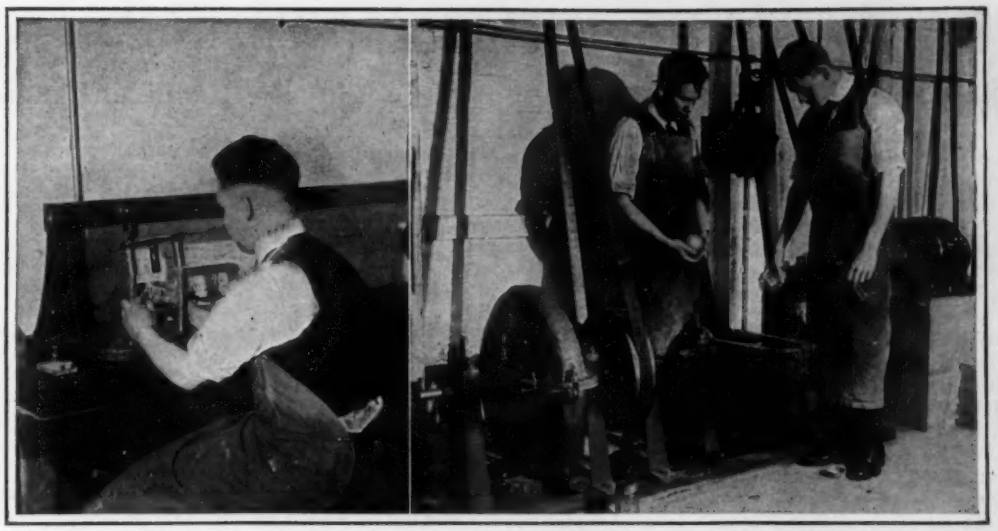
The hollow cylindrical drill which cuts from stone the cylinders used in the tests

Hardness test. A revolving metal disk, set against the stone, measures the amount of abrasion

has been drilled perpendicular to the plane of the rock, and thoroughly dried, is inserted in the brass grip of what is known as the Dorry Hardness machine. As the picture shows, this device is one which wears down the rock core against a revolving steel plate, a definite quantity of sand of known quality and size being used for the abrasive. Before the test is begun, the end of the specimen in the grip is worn down on the steel disk until it is flat against it. Grip and specimen are then brought to a standard weight (using steel washers on the grip for the purpose), after which the steel disk is revolved at the rate of thirty revolutions a minute for 1,000 revolutions.

The difference in weight before and after the test is the variable factor in a fixed formula for obtaining what is called the hardness coefficient in a scale of 20. The hardest varieties of quartzite will show a coefficient of as high as 19.7 while the soft

(*Concluded on page 200*)



Right: grinding rocks to be made into briquettes. Left: molding briquettes to be tested for cementing value

Sandbag Armor on Warships

AMONG the many novelties called forth by the exigencies of the present war is that of using sandbags on warships for the overhead and side protection of batteries, a case of which is shown in the accompanying photographs taken on board a British monitor in the Adriatic.

The sandbag and its forerunner, the bastion, have always been associated in our minds with land batteries; and never has the sandbag been employed on such an elaborate scale as may be witnessed today on the western fighting line in France, Italy and the Balkans—to say nothing of Palestine and Mesopotamia.

It is a pretty safe guess that the use of sandbags on these British monitors in the manner shown in our illustrations, is due largely to attack from the sky. High angle fire from howitzers and mortars, also, since it drops almost vertically upon its target, may have been an additional compelling motive.

It will be noticed that as regards the turret, the sandbags have been massed where the turret armor is weakest, namely, on the roof both of the turret and the barbette. These parts of the heavy gun emplacement were designed to resist shells coming on the comparatively flat trajectory of high velocity guns, and against that kind of fire the thin armor was fairly sufficient; but one of the surprising developments of this war is the extraordinary ranges at which fighting has begun, and in some cases has been carried out. Such long-range fire means that the angle of fall is steep and that the roofs of barbette and turret, which were comparatively impervious to heavy gun fire at moderate ranges, are all too weak to resist attack at extreme ranges, when the shells strike horizontal armor with a dangerously large angle of impact.

Turning to the illustration showing an anti-aircraft gun in action, it will be seen that the sandbags offer no protection against the bombs which might drop within the gun emplacement; but it will afford good protection against the flying fragments of bombs which strike the deck outside of the emplacement.

These British monitors are a new type which has been designed for fighting under special conditions. At the beginning of the war there were three of these vessels, known as the "Severn," "Mersey" and "Humber," which were built by Vickers for the Brazilian navy and were purchased by Great Britain when the war broke out. They were 265 feet in length, 49 feet in breadth, and had a light draft of 4½ feet. They carried three 6-inch rifles, two 4.7-inch howitzers, and some smaller pieces. They had the characteristic low freeboard of the monitor and the upper deck was protective. These vessels were used in the early months of the war, and proved so satisfactory for work in shoal waters, that six larger monitors were designed which carried a few of the heaviest naval guns and were remarkable for their special under-water protection against the torpedo. This protection consisted in swelling out the sides of the ship just below the water and providing an anti-torpedo compartment extending the greater part of the length of the ship, which was about ten feet in width and was filled with some water-excluding material. This protection seems to have been very effective, for it has been stated that these vessels have taken the blow of the torpedo without suffering severe disablement.

There is some doubt as to the characteristics of the guns which are carried. Jane apparently endorses the public statement that certain of the 15-inch guns intended for the new Royal Sovereign class of dreadnoughts were appropriated for the arming of these monitors. He also stated that the 14-inch guns which were ordered in America for the Greek battle-cruiser, "Salamis," were mounted on certain of these vessels.

Public announcement has been made from time to time of the employment of these ships off the coast of Belgium and then later in the Adriatic; in both places they are credited with having rendered excellent service.

French Official. Copyright, Committee on Public Information

Temporary bridge building carried out by French engineers

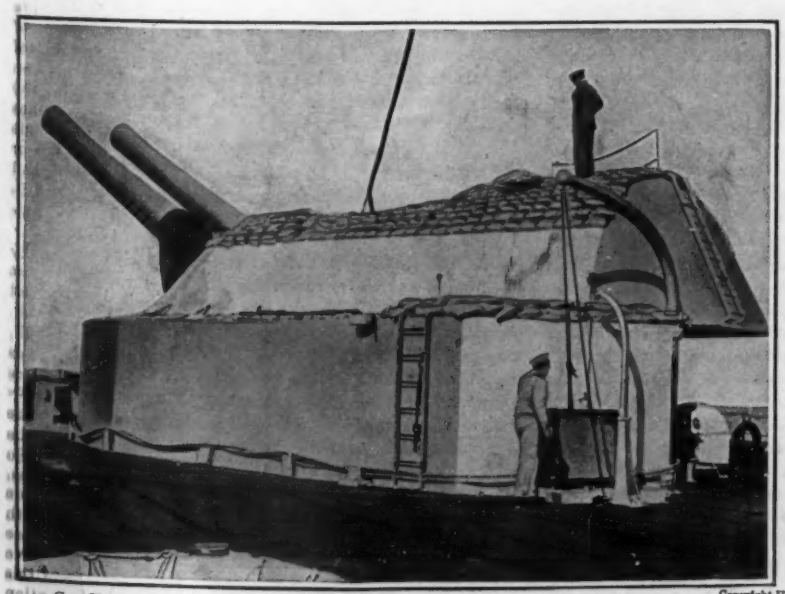
Building a Pile Bridge to Victory

TO the military engineer falls the task of repairing all damages inflicted by the retreating enemy or brought about by his shell-fire and aerial bombs. Among other things the enemy delights in destroying bridges, but in this connection he is not committing atrocities. For bridges are the very arteries over which the soldiers and their supplies flow in never-ending streams toward the enemy; hence their destruction comes under the heading of military necessity.

French engineers have had their share and more of repair work, for the retreating Hun has not failed to leave a desert behind him. In the accompanying illustration French engineers are shown engaged in throwing a temporary pile bridge across a river in France. By way of machinery they are employing a steel derrick-like structure which serves to swing the wooden piles in position and to drive them down into the soft mud bottom. The pile-driver, it appears, is operated by man-power in the absence of other motive power. Furthermore, as the piles are driven and the bridge proper is laid, the derrick is pushed along so as always to overhang the stream as depicted.

Commercial Importance of New Acid-Resisting Alloys

THE enhanced commercial demand for acid-resisting alloys has stimulated research in this branch of metallurgy and a particularly interesting series of experiments has recently been completed by the University of Illinois Engineering Experiment Station. The work consisted of a preliminary systematic study of alloys of chromium, copper and nickel with smaller quantities of such metals as tungsten or molybdenum. Methods have been developed for making satisfactory castings, while 21 binary and 30 ternary alloys have been prepared, of which the properties have been determined by physical and chemical tests. Their acid-resisting qualities have been investigated by over 300 corrosion tests.



Sandbag protection of the roof of turret and barbette against aircraft bombs

Copyright Underwood & Underwood

Anti-aircraft gun on British monitor protected by wall of sandbags

Putting X-Rays Through Their Paces

The Delicate Problems of Reflecting and Refracting the Roentgen Radiations

FROM the first discovery of X-rays it was accepted that these were truly waves in the ether, wholly analogous to light and heat waves, differing from these merely in length. But it was long impossible to back this opinion with anything more tangible than the vehement assertion that it must be so. The X-rays could be brought within our ken and reconciled with other phenomena by supposing them to be ether waves; if this supposition were to be rejected, there could be only chaos in its stead.

So accepted it was, while workers all over the world sought assiduously for experimental evidence in the case. Now if we are to prove these emanations to be waves, we will naturally try to show that they behave like other waves. The outstanding characteristics which the more ordinary ether waves display are their susceptibility to reflection and refraction. If we interpose in their path a material obstruction of some sort they are bent or broken off short and turned back again—unless, indeed, they be completely absorbed. So countless efforts were made to reflect or to refract X-rays. Substances in plenty were found which were wholly or partly opaque to them, and which would therefore absorb them to greater or less degree; and this in itself was an item of consequence. But every effort to make them duplicate the other two familiar phenomena of light was a total failure. The X-rays simply refused to be reflected or refracted.

Smooth and Rough—a Matter of Definition

It remained for Professor Laue of Munich to hit upon a reason for this stubbornness and to suggest a remedy. He argued that reflection implies more than a mere turning back of the train of waves; it implies turning them back uniformly. This means, in the first place, that all waves striking the reflecting surface from a given direction must be sent away in some one direction; otherwise we have no true reflection at all, but rather diffusion. Light is reflected from a mirror; it is merely diffused from a rough table-top. In the second place, all waves coming to the surface in the same phase—crest to crest and trough to trough—must be similarly sent away. Now if there are in the reflecting surface any roughnesses whose height is more than a small fraction of the impinging wave-length, waves traveling toward the surface in the same phase will not hit it uniformly; they will hit the high spots and the low spots in improper phase, and hence will be reflected in different phases. So we will have a train of waves traveling away from the surface, but with crests and troughs completely jumbled up. The physicist has a name for this; he calls it interference, because crests and troughs which are not in synchronism catch hold of one another and kill one another off.

A rough surface, then, will not reflect properly for two reasons. It does not define a uniform angle of incidence, and hence defines no uniform angle of reflection; it diffuses, rather than reflects. And instead of sending back a uniform sheaf of waves in the same phase, it sets up interference, and the bulk of the waves it tries to reflect are thus lost.

Light waves have a length of .0004 to .0007 millimeters for the visible portion of the spectrum. This is small enough in all conscience; but it is not so small that we cannot prepare surfaces that will reflect them uniformly. The case is far different when we deal with X-rays. For of these the wave-lengths are about .00000001 millimeter. Surfaces which are to all intents ideal planes when measured in light wave-lengths become positively mountainous when we refer them to the infinitesimal length of an X-ray wave. And when we permit a series of such waves to fall on one of these surfaces, instead of being nicely reflected at a uniform angle and in phase, they are scattered in all directions and all phases.

Smooth in Billionths of an Inch

The effort to reflect Roentgen rays resolves itself then into a search for a substance capable of reflecting them. We can hardly hope to manufacture an artificial surface which shall be smooth when measured in terms of a billionth of an inch. So we must seek for a natural surface; and at once we see—after Professor Laue has pointed it out to us—that the one place in nature where plane surfaces occur is in crystals.

Crystallographers tell us that the crystal consists of atoms arranged in formal systems, more or less complicated, but always decomposable into planes. There are always these definite planes of atoms, one atom thick; and not only are these planes smooth when measured in billionths of an inch, but they are equidistant from one another under the same exacting criterion. So Professor Laue said he would reflect X-rays from the cleavage planes of crystals; and he—or his followers—did just that.

Before success was met, however, another complication appeared. The crystal, as we have seen, is to be thought of as a series of plane surfaces, one above the other, equally spaced. But these surfaces are not opaque to X-rays. A beam falling upon the uppermost plane of a crystal will be partly reflected, partly transmitted to the next plane; here it will again be partly reflected and partly transmitted; and so on indefinitely, since in a crystal of tangible size there is a prodigious number of cleavage planes. We have then a vast quantity of relatively weak waves emanating from different depths in the crystal. In general these will not fall in the same phase; and they will interfere and kill one another off. Here we have even more light thrown upon the inability of ordinary substances to reflect X-rays. The rays are transmitted or absorbed or reflected promiscuously by particles of the substance which bear no definite relation to one another. Hence weak reflected waves proceed literally from *all* depths and it would not be possible so to regulate conditions that interference would be avoided. But with the crystal such regulation is possible.

The Merry Little Game of Coming Out Even

When a beam of light is split up and partially reflected by the cleavage planes, the reflected rays obviously have a greater distance to travel, the greater the depth from which they are reflected. But between two rays reflected from two given levels these distances are fixed, so long as the incident angle is kept unchanged; and their differences are likewise fixed. In particular, this so-called "path-difference" is constant for two successive planes of reflection. Now if Mr. A goes around the block in one direction, and Mr. B in another, and if Mr. A's speed is exactly two or three or four times Mr. B's, the two will meet again at the starting point; but if Mr. A's speed is one and a half times Mr. B's, or any other fraction multiple of Mr. B's, they will not so meet. And just so, if the path-difference is an exact multiple of the wave-length, the ray which has the longer path will, in its excess distance traveled, present an exact whole number of waves, and "come out even" with the ray taking the shorter path. If this holds between any two successive planes, it will hold, by virtue of the equal spacing, between any two planes whatsoever, and so for all the planes; and if rays then come to a crystal in phase, they will go away from it in phase. The result is not merely that the bad effects of interference are avoided, but that we have a type of interference actually advantageous. For when a lot of weak waves are piled together in phase, crest to crest and trough to trough, we get an effect equal to their combined strength.

Let us see just what this involves. The path-difference depends upon the diagonal distance between the planes, along the path of the rays. This in turn depends upon the perpendicular distance between the planes and upon the angle of incidence. The former is fixed and immutable; the latter we can vary at will. For any crystal and any wave, of whatever cleavage distance and whatever length, there will be some angle or angles for which the path-difference will be an exact multiple of the wave-length, and for which we will accordingly get a maximum reflection of measurable magnitude.

Now that We Have It—What?

Taking advantage of all this, Laue's disciples, Friedrich and Knipping, and after them Bragg and Mosely in England, succeeded in actually reflecting X-rays from a crystal. In Bragg's demonstration the reflection was so strong that only a few minutes' exposure was necessary for a distinct impression upon the photographic plate. This was because Bragg had a far better conception of what was actually taking place than had Laue. The German apparently regarded the phenomenon purely as one of reflection; but Bragg realized that his crystals were so lacking in opacity to the X-rays that the reflected waves could at best be but a small fraction of those incident, and that in order to make them strong enough to record their presence they must be piled up by means of the systematic interference in phase of which we have spoken. So he concentrated his attention upon that aspect of the problem, and successfully.

The consequences have been far beyond anything Bragg could have foreseen. In the first place we have an elegant means of X-ray analysis. It is easy enough to identify the smallest angle of incidence which causes a given X-ray beam to be reflected from a given crystal; and this makes possible an accurate determination of wave-lengths which had before been realized only in the wildest dreams of the physicist. Moreover, we have a tool for crystal analysis of extraordinary power, and from a most unexpected quarter. Among others, the crystals of rock salt, potassium chloride, diamond and selenium have given up their secrets under this searching probe.

But by far the most notable result of the new technique is that obtained by Moseley, a brilliant young Englishman who fell in the summer of 1915. Moseley found that each element, used as X-ray-producing target, gives off a characteristic ray. He found, moreover, that the product of atomic weight by the square root of the X-ray wave-length is constant—the same for every element. Not only has this extraordinary fact thrown great light upon the theory of atomic structure, but it has given new and valuable evidence that all the elements are closely related. It has added greatly to the probability that all elements are formed from one primordial element—hydrogen, without question. Finally, it has come very close to establishing conclusively what had already been suspected—that there are but 92 elements.

In spite of all these remarkable achievements, however, the technique employed is really, in a sense, a crude one. Crystals are not large; especially they are not thick; above all they are not nearly opaque to X-rays. With the best of apparatus and the best of workers the reflected beams are feeble, since by far the better part of the incident beam passes through the crystal and is lost.

Focussing X-Rays

On the other hand, the interference-reflection presents about the only means available for doing with X-rays what it is so easy to do with light—that is, for sifting out a beam of single wave-length from the complex beam given off by the X-ray target. Such pure, simple beams would be of tremendous importance if we could but produce them of considerable power. So on every ground it is desirable to increase the yield of the interference-reflector. And if we are to reason once more from analogy with light, the rational line of attack would seem to lie in an attempt to focus the rays in subjecting them to the interference-reflector.

This problem has been attacked with success by Dr. Elmer Dershem of the University of Iowa. The preliminary argument was fairly simple. Obviously the thing to be done is to secure an interference-reflection effect from curved surfaces—surfaces which will act upon the X-rays as a curved mirror does upon light, reflecting them back through a focus. If we are to bend the cleavage planes of a crystal into such a curved surface, a crystal with very definite planes is needed, and one which we can bend with reasonable ease; and so mica is the logical choice.

Next comes the question of the shape to be given our reflector. In order to maintain the condition, necessary for interference-reflection, of equal angles of incidence, we must get away from the parallel emission of rays from the source; for the only "curve" which makes equal angles with all the lines of a system of parallels is another straight line, and a rectilinear or plane mirror will not give the refraction which we seek. The obvious way out is to reduce the area of the region on the target which generates the X-rays, and then consider the system of rays as diverging from a point. It then becomes necessary merely to ask what curve has the property of making equal angles with all lines emanating from a given point; and the answer is at once a logarithmic spiral.

So if we make our mirror in the form of an open-end barrel of mica, every stave of which has the form of the appropriate logarithmic spiral, we can shoot the rays in at one end with the assurance that they will strike at equal angles, and be reflected at equal angles out the other end. But here we meet a complication. The logarithmic spiral is not a symmetric curve; it curls more sharply at one end than at the other. Its property of making equal angles with radiating lines does not, of course, apply to all points; so it will readily be seen that the rays which are shot out of the back end of the barrel mirror, while to be sure they leave the mica surface at equal angles, will not be projected through any single point. In order to bring about such a projection—or focusing—we should have to turn the whole barrel, end for end; but this again would present the wrong end to the impinging rays, and destroy their property of uniform incidence.

So a compromise has to be effected. A comparatively short segment of the spiral is taken, which is almost symmetric; and then, while the rays are not focused perfectly to a single point, they are focused fairly well. There is, moreover, scope for adjustment. We shall, of course, in order to make the volume of focused rays as large as possible, want as long a mirror segment as we can have without causing too much fuziness, or spreading, at the focus. On the other hand, we shall want as sharp a focusing as we can have without making the mirror too short to give a decent volume of rays. So we must seek a balance between intensity and sharpness.

Dr. Dershem has actually constructed mica mirrors of logarithmic-spiral section, as outlined here, and with them he has refracted X-rays most successfully. Those who are interested in the story, beyond what we have told of it here, are referred to the SUPPLEMENT of this week and next, in which it is told with more attention to technical detail, and with a quantity of illustrations.

Analysis of British Warship Losses

Number of Vessels Lost During the War and Causes of Their Destruction

By Percival A. Hislam

MANY efforts have been made from time to time to analyze German naval losses according to their cause—gunfire, torpedoes, mines, and so on—but a similar process seems never to have been attempted in the case of British losses. This is the more curious because the British naval authorities are much less reticent than the German with regard to their losses, while in the nature of things—the British fleet having to keep the sea at all times and in all weathers—there is a great deal more material to work upon.

In any survey such as is made in the present brief article it is necessary to restrict the classes of vessels dealt with, for reasons of which many are obvious. For instance, losses of submarines are very rarely announced. The sinking of only one British craft of this type (the C34, sunk by a German submarine last July), has been announced since April, 1916, but it is not conceivable that this can represent the only wastage that has occurred in such a period. It is also the custom of the British authorities to announce only in special circumstances the destruction of small mine-sweepers converted from fishing craft, though all losses of sweepers of a larger type, and those specially designed and built for this service since the outbreak of war, are published. For these reasons, among others, the details that follow are confined to warships of the more familiar types—battleships, cruisers of all classes and destroyers.

Dealing first of all with battleships, including battle-cruisers, the losses of the British navy down to the end of 1917 amounted to 15 ships. Three of these, all battle-cruisers, were destroyed by gun-fire in the battle of Jutland Bank, and the only other one to be sunk by an enemy surface ship while actually in action was the battleship "Goliath," torpedoed and sunk by the Turkish destroyer "Mauvenet-i-Millet" in the Dardanelles on the night of May 12th, 1915. Four were accounted for by submarines—two off Gallipoli, one near Malta, and one in the English Channel—while two were destroyed by internal explosions arising from unexplained causes. The remaining five were sunk by mines; but this total includes the "Irresistible" and "Ocean," whose destruction in the Dardanelles on March 18th, 1915, is believed by many to have been caused by dirigible torpedoes discharged from stations which the Turks are known to have prepared on the shores of the Straits.

The cause of British capital ship losses has, following the official accounts, therefore been as follows: Mines, 5; submarines, 4; gunfire, 3; internal explosion, 2; and one from a torpedo fired from a surface ship. Eight of the total were sunk by the end of 1915, five in 1916, and only two in 1917, the last being the "Cornwallis," submarined in the Mediterranean, and the "Vanguard," a dreadnought, blown up from within.

Armored cruisers have suffered to the extent of 12 in a total of 34 existing at the outbreak of war. In their case gunfire claims the greatest number, two having been sunk in this way at Coronel and three in the Jutland battle. Four have been submarined—three on September 22d, 1914, and the fourth, the "Drake," not until October 2d, 1917; that is, after a lapse of more than three years. The "Hampshire," in the loss of which Lord Kitchener and his staff were involved, is still stated officially to have been mined, but no corroborative details have ever been made public (such, for instance, as the discovery of other mines in the vicinity where the ship was lost), and many people are convinced that treachery had a hand in the affair. It may be mentioned that large numbers in England, including Lord Kitchener's sister, insist on believing that the Field Marshal was rescued by a German submarine and is now a secret prisoner in Germany. One armored cruiser ("Argyll") has been lost through stranding, and one ("Natal") through internal explosion, the latter occurring when there was a large party of civilians on board. The rate of loss among vessels of this type has, similarly with battleships, diminished considerably, seven having been sunk down to the end of 1915, four in 1916, and only one in 1917.

In the smaller cruiser classes, including merchantmen armed for cruiser service, the numerical losses have been considerably heavier, while they have not fallen off with the lengthening of the war. This is due to the unvarying permanence of the patrol and also to the growth of the submarine menace, the latter being reflected in the fact that while only seven were sunk by submarines down to the end of 1916—that is, in two years and five months—five were destoyed in this way between May and October, 1917. Out of a total loss of 22 of this type only three were sunk in fighting action. The "Pegasus," lying helpless with her fires drawn at Zanzibar, was destroyed by the German cruiser "Konigsberg" in September, 1914; the mercantile cruiser "Alcantara" was torpedoed by the raider "Greif" on February 29th, 1916, after the latter had been reduced to a sinking condition by gunfire; and the "Ben-my-Chree," a seaplane-carrier, was set on fire and destroyed by Turkish batteries in January, 1917. Submarines have accounted for no fewer than 12 cruisers and similar vessels, while one, the "Princess Irene," fitted as a mine-layer, blew up in May, 1915, with great loss of life. The armed liners "Clan MacNaughton" and "Viknor" foundered in heavy seas, critics alleging the cause to be instability arising from the improper mounting of the deck guns and insufficient ballasting; but this has been officially denied. The famous liner "Oceanic" was the first wreck of the war, stranding on the Scottish coast in September, 1914.

Seeing that England had about two hundred and fifty destroyers in commission at the start of the war and that these craft from the very beginning have been worked far harder as a class than any other, it is remarkable that no loss was sustained until May, 1915, when the old "Recruit" was submarined in the North Sea. Down to the end of that year (in 17 months of war) only 4 destroyers were lost; but 16 went in 1916, and 23 in 1917. The total of 43 is an extraordinarily low one in view of the incessant work of these craft in all weathers, in seas infested with mines and submarines, while the conditions of navigation at night are most hazardous. Thirteen destroyers were sunk by gunfire, eight of them in the Jutland fight; while of the remainder five were submarined, two torpedoed by enemy destroyers and one stranded. Eleven foundered after strkiing mines, and eight as the result of collision, while three sunk on December 22d last were either mined or submarined—it is as yet uncertain which.

Taking these principal warship classes together, British losses down to the end of 1917 may be summarized thus:

	1914-15	1916	1917	Total
Gunfire	3	16	4	23
Submarined	12	3	10	25
Torpedoed by surface ships	1	1	2	4
Mined	6	5	9	20
Collision	—	4	4	8
Internal Explosion	3	—	1	4
Foundered and stranded	5	—	—	5
Total	30	29	30*	89*

*Add 3 destroyers, the actual cause of whose loss—either mine or submarine—is uncertain.

If it were possible to present the details on a tonnage basis the latest year would show a very much lower total than the others, since its total includes 23 destroyers and only three armored ships, while 1916 saw the loss of 16 destroyers and 9 armored ships, and 1914-15, 4 destroyers and 15 armored ships. Needless to say, a single big fleet action fought to a finish would in all probability change most radically the proportion as between ships sunk by gunfire and by other causes, but the above details, summarizing nearly three and a half years of war, are not without their instructive side.

Correspondence

[The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.]

The Elements of Victory

To the Editor of the SCIENTIFIC AMERICAN:

The movements of the world war have been made by successive evolutions of the determining elements of victory. The first element was rapidity of infantry mobilization. Then came rapidity of artillery mobilization, range of artillery fire followed by intensity of artillery fire. This has not been replaced as yet except in the control of artillery fire by means of which advance under barrage is possible and in the degrees of intensity as indicated by the names, hail of fire, curtain of fire, drum fire and hurricane fire.

From following these facts we may gather that a change in the mode of air fighting is about due, and may be looked for at an early date.

Hitherto speed, horizontal and climbing, has been the determining element. Speed, speed and more speed! Each new body design attempts to out-stream-line that of the previous model and motors are stripped and pared to skeleton proportions to assure the light weight for climbing facilities.

The chief arguments in favor of lightning speed are that the aviator outspeeding the enemy can keep in the "blindspot" of the enemy's guns and that he can secure a favorable position for firing upon the enemy plane.

Germany's new planes answer this difficulty by being practically without a "blind-spot." The overpowering numerical superiority of America's planes knocks another prop from under the position-maneuvering argument, inasmuch as they will probably outnumber Germany's planes so much that they can always fight in groups of double or treble the number of the enemies' and can fly in strata one above and one below the enemies' planes, each pair or three fighting a picked machine from the enemy force.

Will Germany have a counterweapon to America's flock of airplanes? Thus far, to every new weapon of the war a more or less effective counter-weapon has been devised. In this case the answer will probably be a large, stable, armored battle-plane, armed with rapid fire guns of much larger caliber than those now used, and embracing the non-recoil principle of the gun described in the April 21st issue of the SCIENTIFIC AMERICAN. I use the word "rapid-fire" here in a relative sense. This with the added stabilization would mean that the Boches could do their fighting out of the effective range of the guns of our planes until the Allies would devise an effectual remedy. However the waning use of a weapon for the aggressive indicates the weakening of the power using it, and the arrival of the American war flock will undoubtedly compel the German air forces to abandon air drives and raids, using their planes solely for defensive purposes. This is one more letter in the handwriting on the wall.

We see many phrases such as "waiting for the spring drive," "during the winter lull," and others implying that, during the winter the armies will crawl back into their lairs and hibernate like bears. Undoubtedly there has heretofore been considerable cessation of the fighting during the winter but, in view of the great reenforcements of the Americans next spring, would it not pay from the enemy's standpoint to make a heavy winter offensive at almost any price? For the past two winters numerous inventions have come to light to give winter comforts to the soldiers and to assist in the winter mobilization of the artillery. By either side concentrating their energies upon this phase of the war, a winter attack would probably be made feasible. It is apparent that a "strategic retreat" would be infinitely more difficult than a winter offensive.

L. B. SWEET,
Private, U. S. M. C.

Santo Domingo, D. R.

New Industrial Uses for Peat

IF the present coal shortage is duplicated, or even aggravated, next winter, as some prophets predict, Americans may begin to make use of the peat beds in various parts of the country. Peat has long been used for fuel in Ireland, Scandinavia, and elsewhere. In Sweden it has even been used of late years for stoking locomotives. But in the United States it has been little utilized except for horse bedding, etc., in certain country districts. It is admirably adapted to this because of its high absorptive power, from eight to twenty times its own weight, its capability of combining with ammonia, of deodorizing liquids and of killing germs.

But it is in Germany that the greatest effort has been made to find industrial uses for it. German technologists have long urged the importance of its latent potentialities, with the result that the Government has opened at Hamburg a laboratory for the investigation of its possible industrial applications, the *Laboratorium für Technische Torfverwertung*, as we learn from *La Nature* (Paris). The same authority states that it has been found possible to extract from peat chemically pure fibers capable of being bleached, dyed, and woven for the making of carpets, draperies, and even of clothes.

Experiments have also been made both at Hamburg and at Dresden with the object of preparing from peat a substitute for wood. This is done by combining it with a wax under a pressure of about 500 atmospheres. The resulting product, or artificial wood, is said to be very resistant to water, to fire and to variations of temperature. It is extraordinarily hard and is suitable for use as paving material, railroad ties, etc. Its cost is about seventy-five per cent that of oak wood of commercial grades.

An excellent filling or "stuffing" for mattresses, pillows, and cushions is also made from peat and is in much demand. It is particularly advisable for use by infants and invalids, because it is so tremendously absorbent.

Japan and the War

What the Mikado's Navy Has Done for the Allied Cause

By Adachi Kinnosuke

WHAT has the Japanese navy done, what is it doing, for the cause of the Entente Allies? The question is getting both fashionable and a bit persistent. It is quite natural that it should be so; these are the days when the Britisher is actually wondering what the British Navy is doing and the American is showing some impatience in finding out just what it is that the American navy is doing.

And as though in answer to the query—not many weeks ago the Japanese light cruiser, "Akashi" steamed

Bodies of first Japanese submarine victims entering port at the naval base of Yokosuka

into the naval port of Yokosuka. She had returned from the Mediterranean. Aboard her she had brought home the remains of Captain Uehara and his men who had lost their lives when the Destroyer "Sakaki" was torpedoed by a U-boat. That was news to the people of Nippon. For the landing of the remains of the "Sakaki's" commander and his men was about the first pointed hint they had had of the war activity of the Japanese navy in European waters.

Since then, the Cruiser "Hirato" has also reported home at Yokosuka. She had been in continuous service for nine months, and had steamed over twenty-six thousand knots. And according to her officers most of that was over pretty stormy waters—her deck often under three feet of sea, while pitching up 35 degrees was such a common experience with her men that they simply said nothing and got used to the thing.

The "Niitaka," another light cruiser, came home after the "Hirato." And the performance of the "Niitaka" has completely eclipsed the feats of the "Hirato." For the "Niitaka" had been out for two years. She had left the naval base at Sasebo in the early days of December, 1915, and had been in continuous service ever since. She had steamed altogether over fifty thousand knots—equivalent to more than twice the circumference of the globe.

Both the "Niitaka" and the "Hirato" have been out on patrol duty—keeping the sea lane from the Far Eastern ports to Suez not only open, but safe from the German raiders. Their work has been unnoted and unsung. They seem to count it lucky that they did not, like Gray's gem of purest ray serene, end by adorning some dark unfathomed cave of ocean. But from the way their men talk, the German raiders were about the easiest enemy they had to contend with. Typhoons, monsoons and other moods of the temperamental South Pacific and Indian Oceans were much worse. But the worst storms encountered were as nothing compared to the laughs of the swivel chair critics at home and abroad. Such critics can patrol the sea lane from Sydney to Suez in a sentence of ten words: naturally they don't think it much of a job. The newspaper readers read the sentence in half a second; they think of it even less than does the erudite author. But to the men and ships of the Nippon navy who measure the sea at 10 and 15 knots an hour, it looks entirely different—this business of patroling the 6,000-mile path through the world's wildest waters, from Sydney to Aden. This task is anything but a joke, anything but a sinecure, when the crew is rolling and staggering through three feet of water above deck, with the captain on the bridge looking like a drowned rat.

When that famous German raider "Emden" was having her little game with the merchantmen to the tune of 20 ships and $20,000,000, the query, "Where's the Japanese Navy?" was persistent enough to get on the nerves of the men of the Nippon navy. When the raider was at last sent to the place whence she will never come back—not by a ship of the Japanese navy but by a modest little Australian cruiser—the query turned into a laugh. It was not a pleasant laugh in anybody's ears, more especially so not in the ears of the men of the Imperial Japanese navy. The world laughed at them—then. All that has changed a little since.

When the commander of the Japanese squadron which convoyed the British Colonial troop ships all the way from the Far East to Europe reached London, the men of the British navy said nice things to him, gave him a little silver trophy as the token of their high appreciation of his work, and told him at a public banquet that it was due entirely to the work of the Japanese navy that the Australian cruiser, "Sydney," was able to get on the track of the "Emden" and sink her off Cocos Island—because if the Japanese ships had not covered so well the route through the Indian Ocean and the South Pacific, the Australian cruiser would never have been able to chase the German raider to its final destruction. The same could

Rear Admiral Yamaji of the Japanese scouting squadron and his daughters

be said of the destruction of the German fleet under Admiral von Spee off the South American coast by a British fleet.

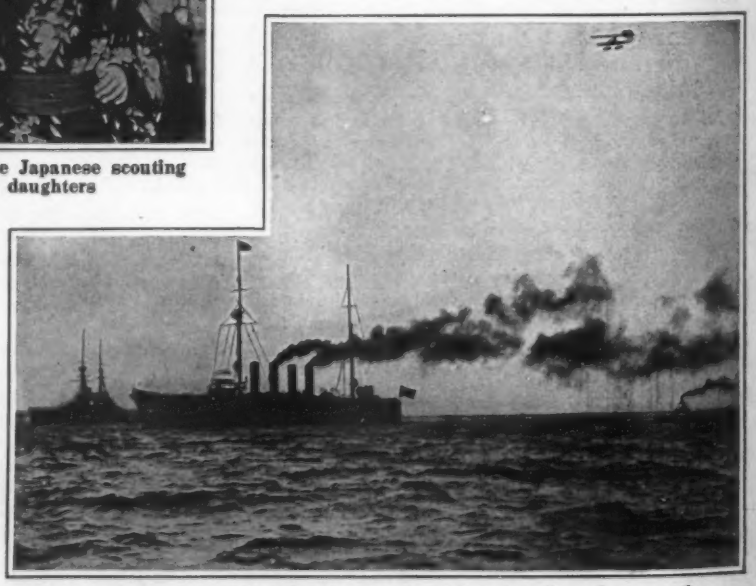
But all this work of the Japanese navy in patroling the Pacific and keeping the sea lane open from the Far East to Europe has been published from time to time—likewise the part the Navy played in driving Germany from her Far Eastern base at Kiauchau. What the American public has not heard so much of is what the Japanese navy has been doing to help France and the other Entente navies in the waters of Europe.

Rear Admiral Moriyama made a statement recently about what the Japanese navy has done in furnishing new destroyers to the French navy. That was entirely a bit of news to most of his own countrymen and doubtless so to the general public of Europe and the United States. The Admiral's remark had no reference to the Japanese destroyer and cruiser squadron under the command of Rear-Admiral Sato which is fighting U-boats in the Mediterranean in coöperation with the ships of the Entente navies. He meant that the Japanese navy yards had built a number of destroyers for the use of the French navy. He did not specify the exact number—he merely indicated that it was more than ten. And according to the same high authority, the Japanese navy did more than build these destroyers for the French navy. When they were ready for service they were delivered—the men of the Japanese navy took them from a Japanese port clear over to the French waters.

Not so many weeks ago, one of the sons of an ex-President of the United States was aboard an American transport making for a French port. The ship was passing through a danger zone. The ex-President's son and his comrades noticed that the transport was being convoyed by warships. What they did not expect to see was the flag of the Japanese navy; but it was there just as red and just as white as ever. The sight was something of a shock—decidedly pleasant to the ex-President's son as the story goes. It seems to have sent the first definite realization that Japan is in fact one of the fighting allies in this great world war.

But when the Japanese navy turns to thoughts of Russia, then a wistful shadow falls athwart its war reflections. For after all, it is neither France nor the British Empire to which the Japanese navy has devoted its greatest efforts. From the very opening of the war, Russia claimed its prime and instant attention. As soon as Japan entered the war on the side of the Entente Allies, the Japanese navy sold back to Russia three ships of war which it had captured from her in the war of 1905—the battleship "Sagami," the "Peresviet" of Russian memory, of 12,674 tons; the battleship "Tango" of 10,960 which once was the Russian Poltava, and the famous "Variag," renamed "Soya." These ships had been almost completely rebuilt and refitted since they had been captured from Russia, and so improved that they were very far from being a lot of antiquated tubs rich only in heroic memories. The Japanese did very well in selling them over to Russia; for it was at once a very graceful act and, from the standpoint of the Entente cause, an effective one. It wiped off the last vestige for Russia of the humiliating memory of the Russo-Japanese war, and at the same time added three good ships ready and fitted for instant service under the Russian flag.

But of course selling the three ships was a mere preliminary bow of courtesy. The real service which the Japanese navy rendered to Russia was in freeing her entire Pacific fleet from any further war duties and especially from any duties in connection with the guarding of the line of communications and supplies from Japan and the United States. It has even been said that the Japanese navy so far forgot its dignity in its eager desire to serve its Russian ally that it even played the good natured errand boy and brought the Russian gold all the way across the Pacific to a North American port. And while the present state of Russia is quite enough to make her friends shake their heads more or less gently, even so, the Japanese navy does not seem to take the view that all its past arduous efforts in Russia's behalf are altogether in vain.

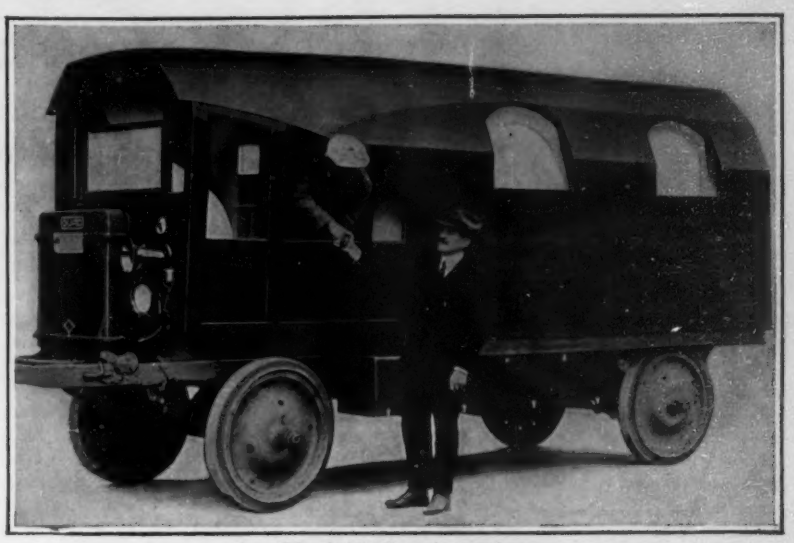


Japanese cruiser "Hirato" returning to Yokosuka after nine months continuous service against German raiders

Cambridge Observatory in the War

THE staff of the observatory of Cambridge University has been reduced to one member—the director—by the loss of his two assistants in the war. Mr. Hartley, first assistant was killed on the "Vanguard" last summer, and Mr. F. Entwistle, second assistant, was recently killed in France where he was serving as a lieutenant in the Norfolk Regiment.

Hollowing out the huge redwood trunk to form the motor-car body



The finished car in service

An Automobile Body in One Piece

HERE is the story of the modern tree man. He lives in the trunk of a huge redwood tree mounted on top of a motor truck, and travels about the country enjoying practically all the comforts of a three-room apartment. First cutting a 22-foot section from a fallen redwood, 360 feet long and 11 feet in diameter, he proceeded to fashion the huge piece of timber into an automobile body which has no counterpart in this or any other country.

Mr. Charles Kellogg of Santa Clara County, California, is the owner and builder of this remarkable vehicle. The tree from which the body was made was a fallen monarch that had been lying on the ground for perhaps a hundred years without any sign of decay. As a matter of fact, the wood was found to be full of sap and alive notwithstanding that the tree had been uprooted for a century. The 22-foot section when first cut—a 14-foot saw being used for the purpose—weighed approximately forty tons.

The first step after the section had been cut was to remove the bark. Then the task of hollowing out the trunk was begun. This was found to be most difficult. A couple of expert axemen first attacked it, but at the end of three days were worn out and gave up the job. Oxy-acetylene was then tried, but this also failed, as the redwood proved impervious to the flame, the wood carbonizing in a wall.

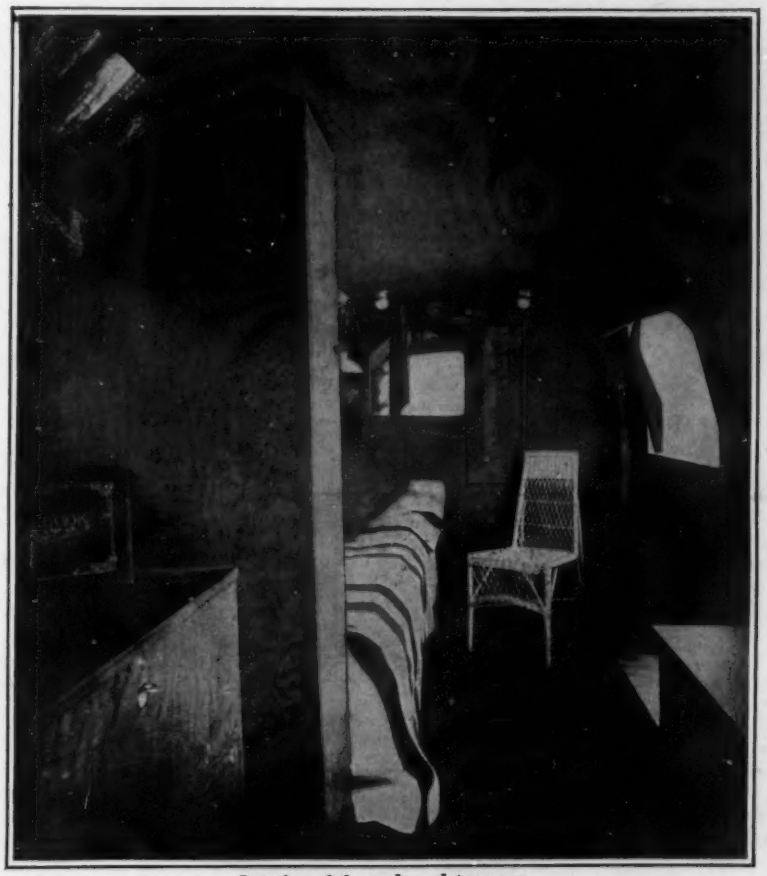
Mr. Kellogg then put some of his own ideas into operation. He first drove a gas pipe through the heart of the log, using the truck on which the body was to be mounted as a battering ram. This small aperture was enlarged by a pepper wood chisel fastened to the front of the truck with chains. Then the hollowing out process was completed with a 22-foot chisel operated in the same manner. This left a shell one foot thick and Mr. Kellogg trusted to his eye alone in smoothing out the log and modeling it as a sculptor would into a beautifully shaped body.

As the shell in its unfinished state weighed in the neighborhood of 6,000 pounds, the problem of mounting it on the truck was a difficult one. This was finally solved by cribbing the corners with slabs and digging a passageway in the soft forest floor beneath. The truck was then driven under the great log and the latter lowered into place.

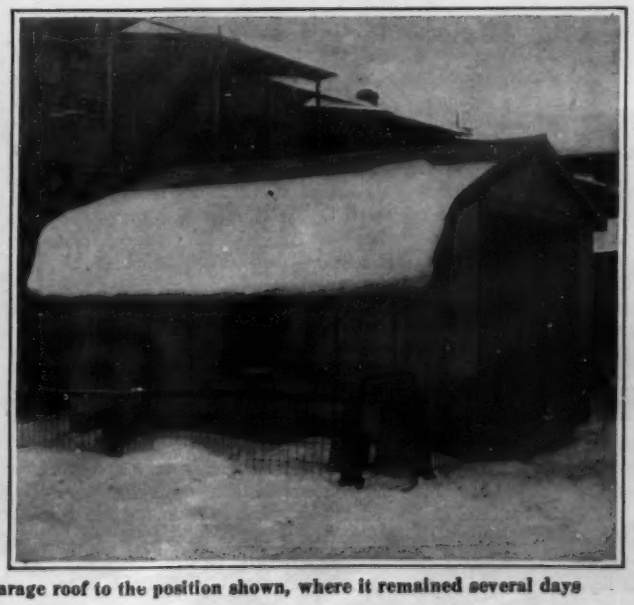
Next came the task of drying out the body without "checking," to get rid of surplus weight. This was accomplished by sealing all apertures and turning on a sprinkler for two weeks. This washed out the sap and hastened the seasoning process. At the end of the two weeks the log had lost 1,200 pounds in weight.

Mr. Kellogg, himself, cut the windows and planned the interior. He found places for two beds, a kitchenette, a yacht lavatory, closets, electric fixtures and wiring. Then came some exquisite cabinet work, clever little drawers, folding arrangements and plate glass windows. The body of the car is 19 feet long and contains three rooms, each six feet square; a living room, a bedroom and the chauffeur's room. The rooms are all luxuriously furnished, a feature of the living room being a small fireplace.

Mr. Kellogg has driven his "Travel-log," as he calls it, more than five thousand miles over the famous mountain roads of California and has found little difficulty in negotiating the steepest grades in spite of the fact that the truck, which was designed to have a capacity of two tons, carries an overload of more than two thousand pounds.



Interior of the redwood-tree car



The snow slid slowly down this garage roof to the position shown, where it remained several days

A Snowslide That Froze Half-Way

THE enclosed photographs taken in Washington, D. C., on January 30th, 1918, were not snapshots of a snowslide, as any one of them might appear, but were slow exposures taken several minutes apart.

Moreover, the snow formation remained for several days. The roof of the garage is about seven feet by sixteen feet, of corrugated galvanized steel, the corrugations extending down the slope of the roof. The layer of snow thereon was about five inches deep; and it began to move at about noon, apparently under the influence of a slight thaw, there being no heat in the building. The movement was so slow as not to be perceptible except by noting the increasing overhang from time to time. The layer projected straight out until the overhang was about two feet, when it began to take a curve, as shown. When photographed, the lower edge was about three feet below the eaves, and about eighteen inches from the side wall of the garage. After that, no further sliding on the roof took place; but the overhanging part gradually straightened down into a vertical position, and finally hung straight down, like a cloth sheet, a distance of about three feet. The under surface of the snow layer was then still quite soft, but the upper surface was covered with a thin layer of ice. The hanging part seemed to be quite strong, as the jarring of the building, due to opening and closing the doors, had no effect on it.

Non-Inflammable Celluloid from Beans

ABOUT a year ago a considerable amount of interest was aroused in the United States by the announcement that a professor in one of the Japanese universities had invented a successful incombustible substitute for celluloid, to be manufactured from soya bean cake. At the same time it was found impracticable to secure any more denite information with regard to the project, but recently further data have been received by the Bureau of Foreign and Domestic Commerce. The new product has been given the trade name of "Satolite," derived from the name of the inventor, Prof. S. Sato, and a company for its manufacture has been started with a capital of 2,000,000 yen ($1,000,000). Satolite is a galalith made of the glucine of soya bean, coagulated by formaline. It is said to be produced much more cheaply than ordinary celluloid, and to have several advantages for industrial use not possessed by the latter. The factory is to be built in the Mukojima district in Toyko, and the actual production will begin this autumn.

The Heavens in March, 1918

The Nebulae, Their Nature, Their Size and Their Distance from Us

By Henry Norris Russell, Ph. D.

THE most remarkable advances in astronomical knowledge continue to be in the region of the star clusters and nebulae. A very recent communication from Mount Wilson gives the results of measurement of the rate of rotation of another spiral nebula—this time the Great Nebula of Andromeda. The fact that it was in rotation had been detected by Slipher some time ago; but to measure the rate of motion demands instruments of great precision, and very long exposures. The two photographs of the spectrum of the Andromeda Nebula, on which Mr. Pease bases his present report were each exposed for more than seventy hours—and between them would have occupied the time of the great 60-inch telescope for all the moonless nights of a month, to the exclusion of all other work. As such exclusive attention to a single problem was of course out of the question, the exposure was actually spread out over more than two months—the spectroscope being taken off the telescope and carefully protected against light between the intervals of work.

The results justify the heavy labor. The first photograph, with the slit of the spectroscope parallel to the longer axis of the nebula, as it appears in the sky, shows that the inner portion is rotating very much like a solid body—one side approaching us, and the other receding. The rate of rotation is about eighty-five kilometers—or a little more than fifty miles per second, at a distance of two minutes of arc from the nucleus. The second plate taken with the slit extending in a direction at right angles to the first shows no relative motion of the various parts of the nebula—all of which are approaching us at the same rate of 300 kilometers per second. This again confines the reality of the rotational movement, for rotation would cause all parts of the nebula on this line to be moving sidewise, and neither approaching nor receding from us.

Velocities and Distances

The region covered by the observations extends only about a quarter of the way out to the points at which the great spiral arms separate from the central mass of the nebula; and if the observed law of increase of speed holds good to this distance, the rate of motion along the arms should be something like two hundred miles per second. Within a few years such a motion ought to displace some of the fine details with which this nebula abounds by an amount easily measurable upon good photographs—unless, indeed, the distance of the nebula turns out to be even greater than has yet been supposed—and by comparison of this motion, as observed on the photographs, with the spectroscope results, it should be possible to find the actual distance of the nebula.

Meanwhile, we may be certain that it is very great. The best basis for an estimate which we possess is found in the fact that no less than five "novae," or temporary stars, have been photographed in this nebula. One of them seen in 1885, was of the seventh magnitude, and telescopically a bright object. The other four observed in 1909 and 1917 were exceedingly faint—of the sixteenth to the eighteenth magnitude, and could not have been detected except by photography.

Now, from what we know about temporary stars, it appears very probable that even the fainter ones are much brighter than the sun. This is certainly true of those whose distances we have been able to measure. Nova Persei of 1901 was at least two hundred light years distant, and at brightest must have equalled if not exceeded any other star whose brightness has so far been accurately measured. It was certainly two thousand times as bright as the Sun, and probably brighter still.

The more recently observed Novae in Lacerta and Gemini were also distant—too far for direct measurement to be of much avail—but the observations made on them show that they were at least one hundred times as bright as the Sun, and probably still brighter.

If we assume, as a rough basis of estimate that the fainter Novae observed in the Andromeda nebula were 100 times as bright as the sun we arrive at a distance of about eighty thousand light years for the nebula. On the assumption that they were only ten times as bright as the Sun (which is most improbably low), their distance would still be 25,000 light years; and it may be more than one hundred thousand.

Taking the estimate of 80,000 light years as a basis for further figuring, we find that the extreme diameter of the nebula comes out something like four thousand light years, perhaps one-tenth as big as the Milky Way. The portion within which the motions have been investigated spectroscopically would be about ninety light years in diameter, and would require about a million years to complete a revolution.

Giants of the Skies

Though these numerical estimates are necessarily very uncertain, they suffice to show how truly gigantic this brightest, and probably nearest of spiral nebulae must be. What its real nature is remains hard to determine. Its spectrum, which closely resembles that of the Sun, suggests that it is an enormous star-cloud, so vast and so remote that even the brightest individual stars in it are not separately distinguishable. But, if this is true, it must be far more distant even than we have just estimated; for in such a star-cloud we would expect to find some stars at least a thousand times as bright as the Sun; and since such stars are not separably visible on plates which would show an object of the 20th magnitude, it would follow that the distance of the nebula would be considerably over a million light years, and its diameter some sixty thousand light years, about equal to that of the Milky Way. At such a distance no relative motion of the various parts of the nebula could be detected in a century.

At 11 o'clock: Mar. 8.
At 10½ o'clock: Mar. 16.
At 10 o'clock: Mar. 23.

At 9 o'clock: Apl. 7.
At 8½ o'clock: Apl. 14.
At 8 o'clock: Apl. 22.

At 9½ o'clock: March 29.

NIGHT SKY: MARCH AND APRIL

But, if it is as far off as this, the new star which appeared in the nebula in 1885 must have been actually at least a hundred million times as bright as the Sun, and, as Dr. Shapley points out, have given out much more light than all the stars visible to the naked eye put together. This would be so extraordinary a conclusion that even the student of modern stellar astronomy, accustomed as he is to gigantic figures, recoils aghast. But if the nebula is less remote, say anywhere within one hundred thousand light years, the separate stars composing it ought to be easily seen if it were a cloud of stars. What else can it be? A possible answer is found in a remarkable paper by the English mathematician, Jeans, who has shown that a very large mass of gas, if originally in slow rotation and contracting gradually under its own attraction, would become flattened, then lens-shaped, and that finally, as the centrifugal force increased, the gas would begin to fly off at the rim—probably in two great streams originating at opposite points of the periphery. This certainly suggests a spiral nebula; and Jeans has further shown that, if the stream of escaping matter was big enough, it might separate into successive masses, large enough to form stars by their further contraction. This theory, though so far only tentatively sketched, is very attractive, and seems consistent with the facts so far as they are now known.

In any case, it is becoming clearer year by year that these patches of whitish light in the heavens, usually invisible to the eye, and not often conspicuous even in the telescope, are in reality the vastest and most impressive objects yet known to the human intelligence.

The Heavens

As our map shows, the Great Bear is now high in the North, above the Pole. Draco and Ursa Minor are below, and Cepheus and Cassiopeia still lower and to the left. Perseus and Auriga are in the Northwest; Gemini, Taurus and Orion in the West, and the Great and Little Dogs in the Southwest. Leo is high in the South, with the long line of Hydra below. Virgo and Corvus are in the Southeast, Boötes in the East, and the Northern Crown and Hercules are lower down and to the Northward.

The Planets

Mercury is a morning star until the 13th, when he passes on the far side of the Sun and becomes an evening star, but he is very poorly placed for observation till the very end of the month, when he may be seen in the twilight, setting at 8.15 P. M.

Venus is now well established as a morning star, rising about 4.45 A. M. on the 1st, and 3.45 on the 31st. She reaches her greatest brilliancy on the 16th and is easily visible in broad daylight. The best time to find her will be on the morning of the 10th, when she will be two degrees north and about five degrees west of the thin crescent of the waning moon.

Mars comes to opposition on the 15th, and is visible all night long. He is on the borders of Leo and Virgo and far outshines the brightest stars of other constellations, being surpassed only by Sirius.

Jupiter is an evening star in Taurus, a little north of the Hyades, and remains in sight almost until midnight, in the middle of the month.

Saturn is in Cancer, and is visible all the evening and until about 5 A. M. at the beginning of the month, and until 3 A. M. at its close. Uranus is just past conjunction with the Sun, and is practically unobservable.

Neptune is in Cancer, and like Saturn, is observable till well past midnight.

The Moon is in her last quarter at 8 P. M. on the 5th, new at 3 P. M. on the 12th, in her first quarter at 9 A. M. on the 19th, and full at 11 A. M. on the 27th. She is nearest us on the 12th, and farthest away on the 26th. During the month she passes near Venus on the 10th, Uranus on the 11th, Mercury on the 12th, Jupiter on the 17th, Neptune and Saturn on the 22d, and Mars on the 26th.

At 5.26 A. M. on March 21st, the Sun crosses the celestial equator on his northward journey, and in almanac phrase, "Spring begins."

Princeton University, Observatory.
February 19th, 1918.

Recent Changes in Nova Persei

THE nebulosity adjacent to Nova Persei discovered visually by Barnard in December, 1916, has recently been photographed several times at the Mount Wilson and Lowell Observatories. It is small and fan-shaped, and much closer to the nova than the nebulosity which appeared in 1901. A photograph taken October 16th, by Ritchey, with the 60-inch reflector, also shows a sharply defined continuous ring of nebulosity about sixteen seconds in diameter, nearly circular, with the nova at its center. "This ring," says Mr. Ritchey, "will be watched with much interest to see whether it is expanding. If it be the result of the sudden increase of brightness of 1½ magnitudes in the nova between August 16th and August 28th, 1917, as described by Bélopolsky, the present ring may prove to be analogous to the great expanding rings photographed around this nova in 1901-2, but on a much smaller scale."

Proper Motion of the Andromeda Nebula

FOR a number of years short-exposure photographs have been made each year at the Lowell Observatory of the nucleus of the Great Nebula in Andromeda, to accumulate material toward a determination of its proper motion. Mr. Lampland, of that observatory, has also secured some photographs of this object made in England by the late Dr. Isaac Roberts. His measurements of all this material, referred to 24 well distributed comparison stars, show that the proper motion must be very small, thus confirming the earlier visual measurements of Prof. Barnard.

Mechanical Equipment of the Farm

Latest developments in agricultural machinery and practical suggestions for the farmer

Conducted by HARRY C. RAMSOWER, Professor of Agricultural Engineering, Ohio State University

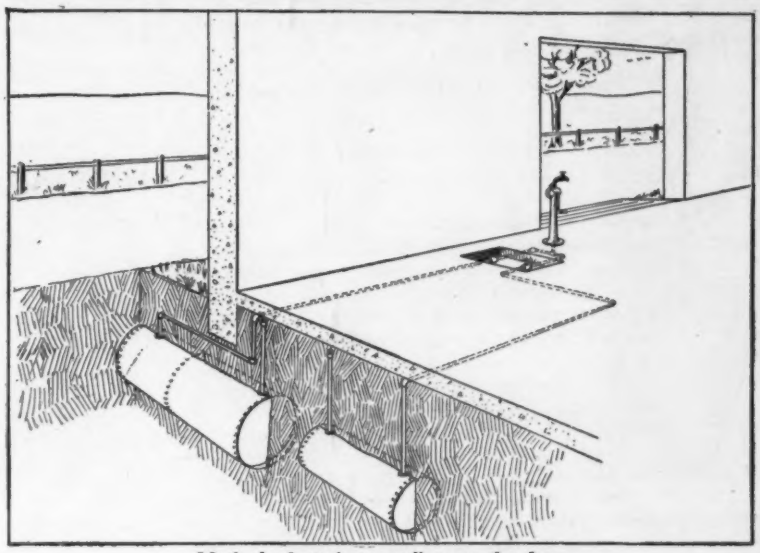
Gasoline Storage on the Farm

By P. B. Potter

IN these days of motorized farming where the automobile, the gasoline engine, the tractor, are all doing duty for the farmer, there arises the problem of supplying these workers with their feed. The purchase of fuel oils for these machines has become as essential as the supplying of any other commodity used on the farm. The ever increasing prices of gasoline and kerosene signal for their conservation and for methods of handling that are less wasteful and less dangerous. This short article begs to suggest a method of storing and handling gasoline on the farm, that is convenient, safe, and efficient.

The storage plant here illustrated consists simply of a heavy steel tank that is placed underground and fitted with a filling pipe and connected to a pump for drawing out the fuel. The tank used should be made of heavy galvanized steel with welded seams and coated on the outside with asphaltum to prevent rusting. It should be buried at least 30 inches below the ground surface and a partial foundation of concrete may be used, although not necessary. The filling pipe should extend a few inches out of the ground. It is fitted with a cap that can be locked and one that gives a small vent for air. The size of the tank will be determined by the number of engines to be supplied from it and by the frequency that delivery can be made to it. The mistake of putting in too small a tank should be avoided. The farmer who has the large tank can usually have his gasoline delivered to him from town, which not only saves him the time and trouble of going after it, but it usually saves him considerable in the price, because he can buy in larger quantities. Also, the supply in the large tank is not so often running out at the busiest moment. A 55- to 60-gallon (one barrel) tank will serve for a single gasoline engine or an automobile. If for both, probably a 120-gallon tank would be nearer the right size. Where a tractor is kept that uses kerosene, an additional tank will be necessary, and it would better have a capacity of 200 to 300 gallons, as the tractor in constant use will use a barrel of fuel in from two to five days.

It will be possible, as is shown in the drawing, to make one pump serve toth tanks, by placing a valve in the suction pipe from each tank. The pump that is used should be of good quality and construction. It may be either of two types. The rotary pump pictured in the drawing pumps the liquid by operation of the crank which turns a pair of cams inside a tight chamber. This type will cost about twice as much as the plunger type which is operated in the familiar way, by an up and down movement of the handle. Both types are connected to the tank by a one-inch suction pipe and both have a capacity of about five gallons per minute. The plunger pump can be drained entirely of its liquid by pushing the plunger clear down. The rotary type is drained by turning the crank backward several turns while the stop cock is open. This feature reduces the chance of leakage to a minimum and permits of the pump being used for both fuels. Each pump is fitted with a padlock that eliminates the danger of theft and the mischief of children. A 10-foot length of hose attached to the stop cock on the pump makes it very convenient for filling the tank of the car or tractor.



Method of storing gasoline on the farm

The cost of such an installation will depend upon the size of the tanks, the kind of pump chosen, and the distance the tanks are located from the pump. Complete single outfits ready for installation can be purchased for from $35 to $75. A double installation for both kerosene and gasoline, fitted with rotary pump and hose connection, would cost from $100 to $150. This may seem like a large investment for a non-productive detail of the farm equipment, yet such an installation might easily prevent a catastrophe costing a hundred times as much. Safety from fire must be practised wherever possible and especially on the farm where there are not the usual means for fighting fire. Underground storage of gasoline eliminates this danger, complies with underwriters' regulations, and reduces fire insurance.

Fig. 1. Gasoline propelled ditcher

Motor- and Horse-Drawn Tile Ditching Machines

WITHOUT question adequate underdrainage is the only foundation upon which a fertile soil can be built. Fortunately, many of our soils are underlaid with a subsoil sufficiently porous to provide proper drainage. There are, however, millions of acres of land so wet that they either cannot be cultivated at all or, if under cultivation, are not producing maximum crops. On such lands artificial drainage must be resorted to if the surplus water is to be removed. Where large areas are involved, open ditches may be used exclusively or they may be, and generally are, used as outlets into which tile drains empty. There is, of course, a very great advantage in having wet lands which are under cultivation drained by means of tile.

The scarcity and high price of labor have made it increasingly difficult for farmers to get drainage work done by hand. There are, fortunately, a number of machines on the market which make it possible to cut better trenches in less time and at less cost generally than is possible with hand work.

Figure 1 shows a gasoline propelled machine now widely used in all parts of the country. While made in different sizes, the type most generally used by farmers cuts trenches 11 inches or 14 inches in width and up to 4½ feet in depth. It will dig through extremely hard soils with perfect ease. The trench is cut to the full depth and the bottom prepared for the tile in one operation. It will dig accurately to a grade as small as ½ inch in 100 feet. This machine under ordinary conditions digs from 75 to 125 rods of ditch per day. Custom ditchers usually charge at the rate of one cent per rod per inch of depth up to 30 inches deep; that is, a 30-inch ditch would be dug for 30 cents per rod. Depths beyond this are proportionately higher.

This machine may be provided with either common broad-tired wheels or with caterpillar wheels. The latter are generally to be preferred, for with them it is possible to dig in very soft ground.

The accuracy of the work done by this machine is greatly superior to that done by hand. The operator simply sets guide stakes at the proper grade and then while riding on the machine adjusts the grade by means of a hand wheel which enables him to raise or lower the cutting mechanism at will.

Figure 2 shows a ditching machine that is usually drawn by six horses, though, as pictured, a tractor may be used. As shown in the illustration there is an endless chain elevator about 11 inches wide and 12 feet long supported in such a way that the front end is adjustable as to height.

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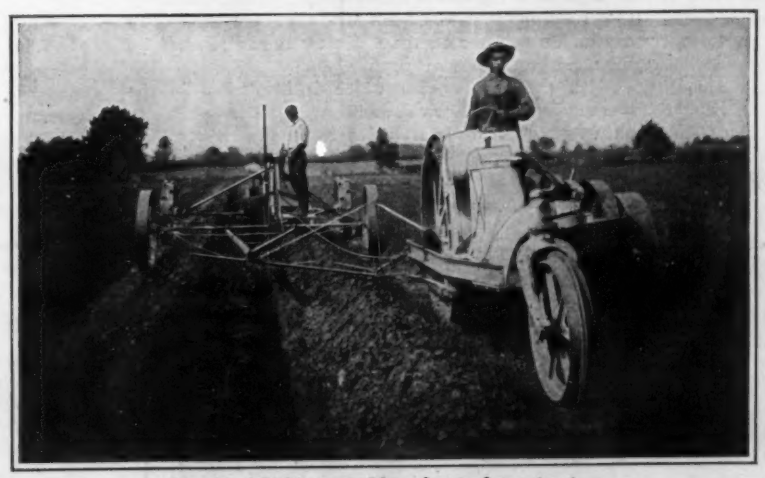


Fig. 2. Ditching machine drawn by a tractor

Fig. 3. Ditcher hauled by four horses

Fig. 4. Ditcher built after the fashion of a plow

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Arts

Copyright Brown & Dawson

Akeley motion-picture camera in use to film the spectacular flight of an airman

Motion-Picture Camera that is Different

THERE had been little improvement in the motion-picture camera and this branch of cinematography had failed to keep up with rapid progress in other directions when Carl Akeley, the famous naturalist, sculptor and big game hunter, started out on a motion-picture expedition through Africa. He took along a standard camera such as was, and is still, employed in motion-picture studios and in the field.

But practical experience in the field soon convinced Mr. Akeley that existing cameras were not adapted to the hard service and many requirements of the naturalist-photographer. So he set about designing his own camera, disregarding from the very start the features which had come to be looked upon as the pillars of motion-picture photography, so to speak.

Beyond doubt Mr. Akeley has produced a camera which is far in advance of any other, due largely to the fact that his design is quite revolutionary. To begin with, his camera is made in the circular form shown instead of square. It is made entirely of metal. The operator can watch the image photographed on the film itself during actual filming, so that he sees exactly what is being recorded. This is made possible by the use of an eye-piece and automatic light gate, the latter opening only when the eye is pressed against the eye-piece so as to exclude daylight. Focusing can be done on a ground glass finder without disturbing the film; this is accomplished by a knife mechanism which cuts a circle in the film at the bid of a pull-and-push rod leading to the outside of the camera. An improved film movement is employed, and the shutter is said to possess an exposure efficiency considerably above that of the usual camera. A gyroscope stablizer makes it possible to use the camera without a tripod; and where a tripod is employed it can be of the lightest variety as compared to the heavy, cumbersome tripods called for by the conventional camera.

As his work neared completion Mr. Akeley realized that the requirements of the big-game photographer were much the same as the war photographer. So he at once came to Washington and placed his invention at the disposal of the newly created Photographic Division of the U. S. A. Signal Corps. Major Barnes, Chief of the Division, was quick to see the possibilities of this revolutionary camera, and adopted it as the "box" for our official war photographers.

Since his camera has been taken over by the Government, Mr. Akeley has added several new features which it is not possible to speak of here. Suffice it to state, however, that in this camera the Signal Corps has beyond doubt the most highly perfected motion-picture camera extant.

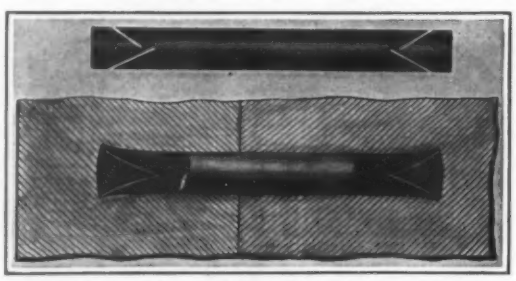
A Dowel Stick Which Wedges Itself in Place

TOO often the tendency of this world is to "let good enough alone." Year after year we keep on employing the same devices in the same manner. Then, one day, an inventor comes forward with a simple improvement on a standard device, and everyone exclaims "Why, I could have done that!" Quite so; but it is the inventor who is never ready to take for granted the perfection of any device who is bound to develop profitable inventions.

A case in point is the dowel stick. It has been made by the millions in the very same manner for dozens of years; it consists merely of a round rod so many inches long, which can be cut to any desired length by the user. But of late Charles E. Evans, an inventor, has patented the arrangement shown in the accompanying illustration. By merely sawing two diagonal slots near the ends of a dowel stick, he makes it self-wedging. That is to say, when the dowel is pushed tightly in place, as shown in the lower half of the illustration, the ends break off and form wedges which serve to expand the dowel and grip it in place.

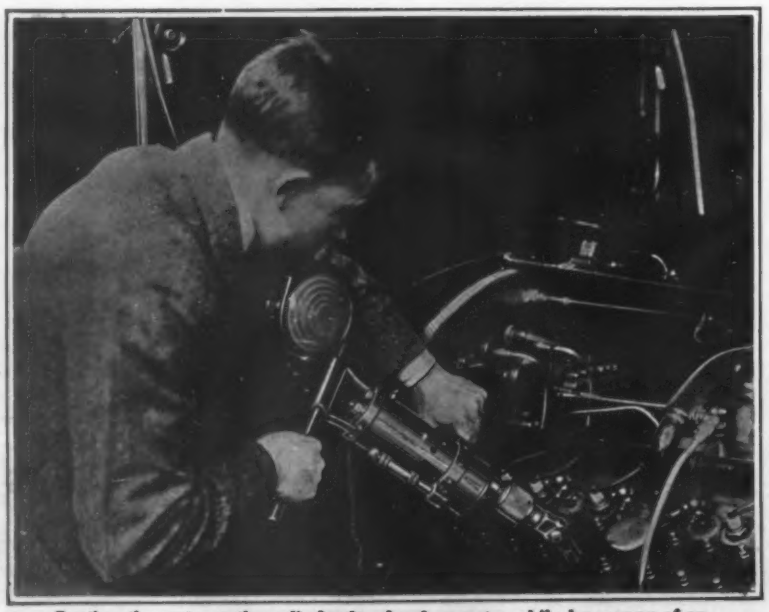
Letting Electricity Turn the Monkey Wrench

AN electric socket wrench that automatically ceases to exert power as soon as the nut is firmly in place, is the invention of Harold Hollingshead of Pasadena, Cal. To be sure, electric wrenches already are common in large factories, but it remained for Mr. Hollingshead to perfect one that would not strip the screw-threads by continuing to force on the nut after it had reached its intended position.



New form of dowel stick and how it automatically wedges when in place

With the new wrench which is illustrated in the accompanying photograph and drawing, it is possible to adjust the pressure at from ten to sixty pounds. This pressure is taken from a 10-inch leverage. On actual tests the inventor has put on and seated 10 nuts by machine while another man has done only two.



Seating the nuts on the cylinder heads of an automobile by means of an electric wrench and universal socket

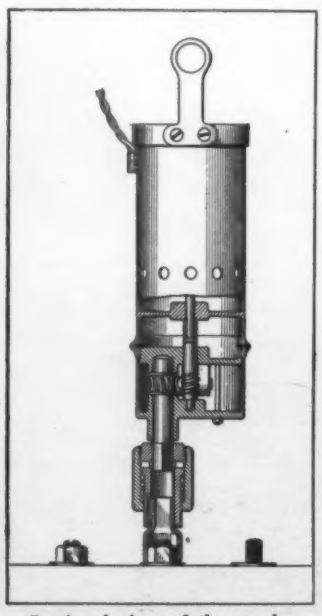
Copyright Brown & Dawson

Filming a long-distance scene with the Akeley camera, by means of a telescope

Compactness can certainly be claimed for the new electric wrench, for it measures only three inches in diameter and eight inches long. It weighs 10 pounds. A 10,000 r.p.m. reversible motor with a switch at the end, drives the socket through a 64 to one double right angle worm and gear drive. Ball bearings insure smooth running. The motor develops five horse-power in torque. There are locking, foldable handles at the sides, with a hollow handle at the end to take a bar, giving a leverage on any sized nut. The electric wrench can be employed with any sockets on the market, sleeves being provided to take up the variation in size.

There is an automatic clutch incorporated in the electric wrench which is adjustable for any accurate pressure in putting on a nut, according to the size, and is a positive drive in taking a nut off. The wrench can be converted into a drill or screw-driver in a second, it is claimed. It operates on either alternating or direct current with equal ease.

With every advantage of the hand socket wrench, the electric type has 10 times the speed. It can be used as a valve grinder, taking all the pits and roughest parts off. The larger size, which is 4 inches in diameter and 8½ inches long, develops 10 horse-power in torque. It can be attached to the crank shaft and braced to the front extending part of the chassis of an automobile and in this manner used as a starter when the batteries or the original starter are out of order.



Sectional view of the newly-invented electric wrench

The Patent Office Society

THE Patent Office Society, composed mainly of members of the Examining Corps of the Patent Office, has just completed its first year of existence. Its objects, as stated in its Constitution are: ". . . to further the industrial development of the United States in so far as the patent system is a factor thereof, to promote and foster a true appreciation of the American patent system, to cultivate a high standard of professional ethics among patent practitioners and examiners, and to promote the professional, intellectual and social welfare of the members of the society." Besides active members, there are provided honorary and associate members, who may be present or retired heads of the Office, persons who have made marked contributions to the advancement of the industrial arts and patent attorneys, inventors, manufacturers and engineers.

The Commissioner of Patents has kindly permitted the use of space in the Patent Office as a place of assembly for members of the examining corps, where papers are read at intervals by men of note in the

(Concluded on page 203)

Proving the practicability of Troy Trailers in "Motor Truck Trains"

On the Mexican border, Troy Trailers, hauled by tractors, are being driven in trains of as high as 19 trailers each, over almost trackless country.

No more convincing demonstration of the practical features of Troy Trailers is possible.

What these huge trains, heavily loaded, can do over roadless country—**your** *motor truck* can do hauling one or more Troy Trailers over **your** roads.

Troy Trailers will solve your transportation difficulties by making yourself independent of railroad tie-ups and freight embargoes.

Troy Trailers

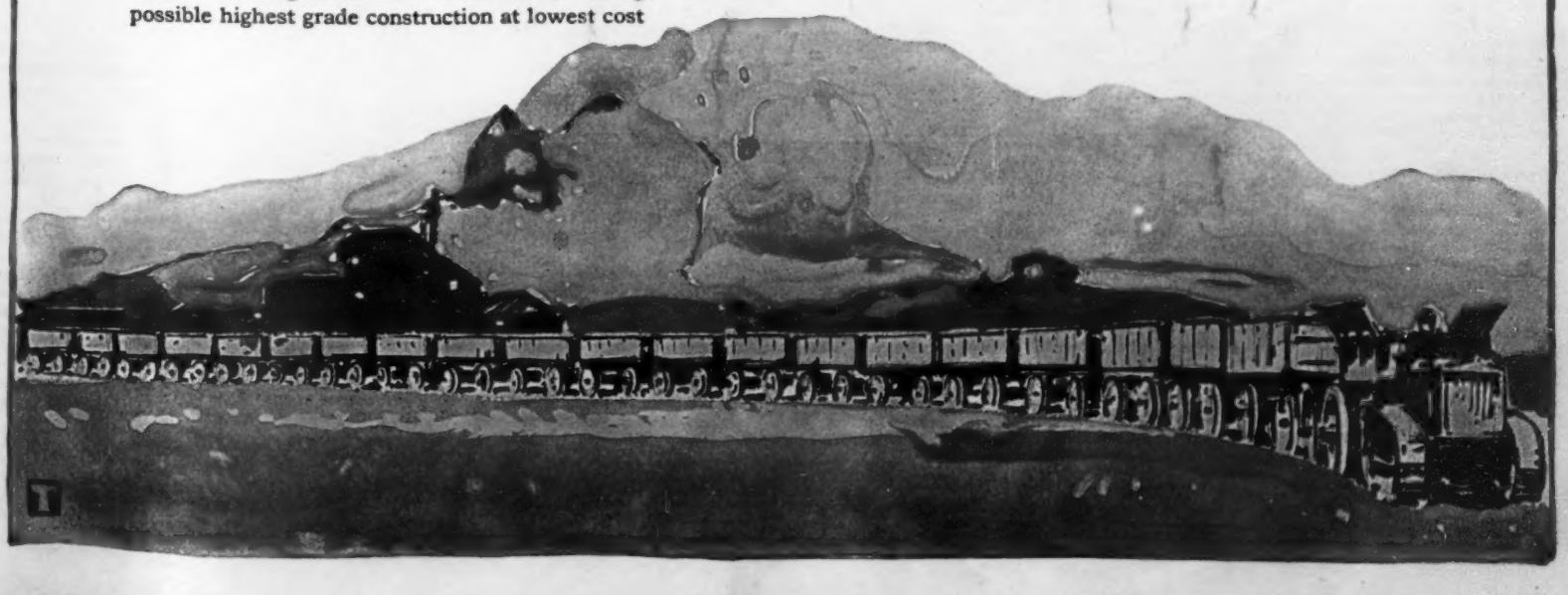
Establish your own hauling service. Hundred-mile, over-night trips are practical. And your motor truck can easily move double its rated capacity by hauling the excess load on a Troy Trailer.

In this way one truck does the work of two—and at an additional cost of only 25% over hauling the truck load alone.

Without Troy Trailers the "motor truck train" is not possible.

The Troy Wagon Works Co.
Troy, Ohio

Oldest and largest makers of Trailers, making possible highest grade construction at lowest cost



RECENTLY PATENTED INVENTIONS

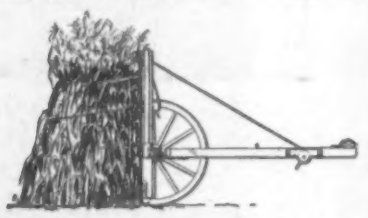
These columns are open to all patentees. The notices are inserted by special arrangements with the inventors. Terms on application to the Advertising Department of the SCIENTIFIC AMERICAN.

Electrical Devices

DETACHABLE CORD SENDING MACHINE CUT-IN.—C. M. HOLMES, 115 W. Forsythe St., Jacksonville, Fla. This invention relates to telegraphy, and deals particularly with means for connecting a transmitting machine such as a "vi-broplex," with the main line through the sending key. The general object is to equip a transmitting machine with a novel connecting means, whereby messages can be transmitted over one or more circuits, without the use of other mechanical means.

Of Interest to Farmers

SHOCK LOADER.—G. HACKLEY, Aholt, Mo. The object of this invention is to provide a shock loader in which the frame is pivoted to an axle which is supported by wheels, means being



SIDE ELEVATION SHOWING FRAME IN VERTICAL POSITION

mounted on the wheels for drawing the shock there against when the frame is in a vertical position and holding it, and means being mounted on a tongue secured to the axle for moving the frame to a horizontal position.

TRACTOR FOR PLOWS AND THE LIKE.—C. A. PETTIT, 3133 N. Sarah St., St. Louis, Mo. The principal object of the invention is the provision of a tractor in which all the wheels are drivers or traction elements and therefore simple means are employed to impart power to those wheels that are used for steering or guiding the machine. Another object is the provision of power transmitting mechanism between the explosive engine or prime mover and the various wheels, whereby the same surface speed of the front and rear wheels is obtained, even though such wheels be of different diameters.

BEET HARVESTING MACHINE.—A. BROTT, Sidney, Neb. The invention relates generally to beet harvesting machines and more particularly to one involving a beet topping apparatus, together with means for feeding the beets as they are dug from the ground to the topping arrangement the latter being of such nature that the beets fed thereto will be cleanly and evenly topped and discharged in conjunction with the remainder of the harvesting machine which includes means for delivering the beets to the topping arrangement.

RAKE.—H. C. MASTERSON, Cle Elum, Wash. The object of the invention is to provide a rake wherein the teeth are mounted to tilt to discharge the load and means is provided in connection with the rear axle and controlled by the rotation for dumping the load of the rake when desired, the said means being normally released, and capable of being connected with the axle when desired.

Of General Interest

CARPET SWEEPER SHIELD.—DORA DUNCAN, address Mrs. J. H. Duncan, 329 W. 82d St., New York, N. Y. The invention relates to that type of carpet sweepers which employ rotary brushes suitably housed, operated by rollers rolling over the carpet, the main object is to provide a readily attached shield for the handle yoke and handle, of a sweeper which will fully protect articles of furniture when the sweeper is forced beneath them, as in the case of beds, chairs and other articles of furniture of the "sanitary" type.

ALCOHOL EXTRACTOR FOR BREW-KETTLES.—B. H. HUBBERT, 3683 E. Pratt St., Baltimore, Md. The invention has for its object to provide mechanism of the character specified especially adapted for condensing and extracting the alcohol from beer to provide beer free from alcohol. The device comprises an inner and outer jacket casing arranged coaxial and spaced apart from each other, and means for supplying a cooling fluid to the casings. In operation the vapor from the brew kettle passes upwardly through the inner and outer casings, and the alcohol is condensed by the cold water in the casing.

ICE-HOOK.—J. G. HEIDT, 221 Harriet St., Evansville, Ind. The object of the invention is to provide an ice-hook or ice-tongs comprising curved arms pivoted together and their shanks provided with right angular inwardly projecting ears, a flexible rubber handle having metal connecting pieces pivoted to and between the ears, whereby when the hook is folded the handle will lie substantially parallel to the hook shanks.

INSULATOR.—O. O. STONE, 404 Nolan St., San Antonio, Texas. The invention has for its object to provide an insulator for use in connection with water pipes and the like, for preventing the passage of electric currents, wherein the pipe is divided, and insulated at the point of division, means being provided at the insolution for conducting the electricity away in order that it may be utilized

WELL BUCKET.—W. BEHAN, Stigler, Okla. The invention relates more particularly to buckets for utilization in connection with drilled wells and consists generally in a bucket shaped with the particular idea in view of adapting it to the withdrawal of water from deep drilled wells and whereby to facilitate its filling when lowered into the water as well as the outflow of the water when raised to the surface.

ILLUMINATED SIGN.—G. R. PYPER, Midvale, Utah. This sign is constructed with translucent portions which are illuminated from behind, members with rotating blades being mounted between the illuminating means and the translucent portions of the sign. Another object is to construct the rotatably mounted members as fans, and operate them by air propelled by a drivenfan, the driven fan also serving to operate a flasher switch, wires from which lead to the lamps used to illuminate the sign.

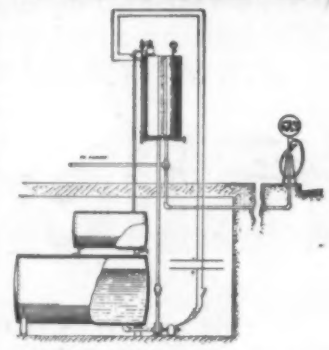
CONDIMENT SHAKER.—E. G. WOODY, care of Keith's New York Theater, 1564 Broadway, New York. Among the principal objects which the invention has in view are, to extract the moistened contents of a deliquescent material from the container provided therefor, to mechanically comminute the material when extracting the same, to assist in drying the material, and to simplify and cheapen the construction of such apparatus.

FLOWER BOX.—J. ISRAEL, 806 Suburban Place, Bronx, N. Y. Among the principal objects which the present invention has in view are, to avoid the accumulation of liquid adjacent the roots of a plant growing in the box, to maintain the earth in which the plant grows in a moist condition, to permit the removal of surplus liquid, to provide a decorative cover for boxes of the character mentioned, and to provide means for aerating the earth contained in the box.

PORTABLE CANVAS LOCKER.—J. A. KULIER, 446 61st St., Brooklyn, N. Y. This invention relates to portable lockers or protective inclosures for wearing apparel, it is especially adapted for use in factories or similar places where garments not used during working hours can be stored away and locked, the invention may be so embodied as to be suitable for use in home closets for protecting garments from dust and moths, the locker can be folded into a comparatively small space when not in use.

DOWEL PIN AND MORTISE LOCK.—A. B. SMITH, 4537 Vonverson St., St. Louis, Mo. The object of the invention is to provide improvements in dowel pins and mortise locks which are strong and durable although very cheap to manufacture, the construction being such that the dowel pin and mortise lock may be used under all conditions without danger of splitting the wood.

LIQUID DISPENSING DEVICE.—W. A. COTNAM, Norwalk, Iowa. An object of the invention is to provide a device which is primarily intended to dispense gasoline, but which does not require the services of an attendant, the purchaser drawing out the gasoline, means being



A SIDE VIEW OF THE APPARATUS, PARTS SHOWN IN SECTION

provided for indicating the amount so drawn, in the office or store of the concern which sells the gasoline, the liquid is pumped out of the tank automatically, means are provided for starting and shutting off the pump.

COMBINATION STRAINER AND SEPARATOR.—M. WEIWODA, 628 Fourth Ave., Brooklyn, N. Y. This invention relates to combination strainers and separators more particularly of the kind used for liquid fuel before the same reaches the carbureter or equivalent device, the object is to provide a straining surface of maximum area through which fuel will pass at relatively low speed, thus reducing agitation of the foreign matter after it has been removed from the fuel.

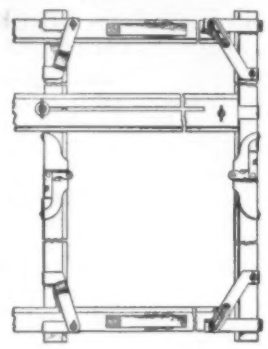
TYPE-COMPOSING APPARATUS.—E. H. BOOS, Missoula, Mont. Among the principal objects of the invention are to increase the speed and simplify the methods of composing type for use in multigraphs and similar printing machines, to prearrange the composed matter before delivering it to the printing machine and to review the composed matter and proof thereof prior to placing in position to print.

PORTABLE COOKING APPARATUS.—LAURA GRIMANI, address L. Woodhouse, 84 Fonthill Rd., Hove, Sussex, England. The object of this invention is to provide a small and compact hot beverage apparatus, and travelers tea kit, such as could be easily taken on camping trips. The invention consists of an enamel cup for making tea, it also serves for coffee, cocoa, soup, etc. The folding enamel handles remain fixed when in use, and do not get hot. The patent strainer removes every leaf of the tea. The device packs every essential, minus water, for 12 successive cups of tea, viz., the tea-box, spirit lamp, which has patent safety base, draught screen, and patent cap to prevent escape of spirit odor, divisional box for matches, saccharine, tabloids, and a spoon. The cover serves as a saucer.

CONDENSER AND DISTILLING DEVICE.—O. A. NENNINGER, 182 Mulberry St., Newark, N. J. This invention has for its object to provide a condenser wherein means are provided for heating and vaporizing the water and for injecting at the same time a current of air to aerate the water as it is condensed.

TREATMENT OF THE ORES OF CERTAIN METALS.—R. LANCE, 332 Rue Saint Honoré, Paris, France. This invention has for its object to provide a process for the treatment of ore of metals such as zinc, copper, cadmium, cobalt, nickel, etc., and more particularly pyritic, oxidized, carbonated, silicated and other ores with a view of extracting the usual elements contained therein. The process consiststs in effecting a complete cycle by converting the metals to be extracted into the form of chlorids, then precipitating them from the solutions while recovering or regenerating the substances which have been used for effecting the chloridization.

CURTAIN STRETCHER.—N. B. ALLEN, Garden City Estates, North P. O., New Hyde Park, L. I., N. Y. Among the principal objects of the invention, are to provide a skeleton frame which may be folded to form a small package, to provide means for rendering the frame rigid when



A BACK VIEW OF THE FRAME

in service, to provide auxiliary means for adapting the stretcher for use when stretching curtains of odd sizes or when it is desired to stretch two or more curtains of relatively different sizes, and to provide folding supports for holding stretchers in service relation.

SAFETY PIN.—E. R. NEBILING, 21 Maiden Lane, New York, N. Y. The object of this invention is to provide a safety pin which will not unlock accidentally. The device comprises means influenced by the stressed condition of the pin for locking the pin to the carrier when the pin is fully engaged with the socket.

BEVERAGE AND PROCESS OF MAKING SAME.—J. G. DEITRICH, address G. L. Thacher, Chehalis, Wash. The invention relates to a beverage, having substantially the composition of human milk, when sufficient water has been added to the product. The process consists in taking fresh cow's milk, cooling immediately after milking, then adding butter fat and milk sugar in syrup form, to bring the ingredients of the resulting product into the ratio in which said ingredients are formed in human milk, the cow's milk and ingredients are stirred, boiled, and rapidly cooled to 50° F., sealed in containers and sterilized in the usual way.

SAFETY RAZOR.—A. H. BRYANT, 17 Battery Place, New York, N. Y. The invention relates to razors particularly a safety razor wherein a minimum number of parts are used and yet the usual effect is produced. Another object is to provide a safety razor structure which utilizes a plastic material, as for instance, celluloid, in all parts except the blade. A still further object is to provide a structure in which a wedge holds the blade in position.

MINE PICKER.—J. WALTON, Phoenicia, N. Y. The invention relates to an apparatus which is adapted to be attached to the bow of a boat to project forwardly so as to serve as means for picking up submarine mines. A more specific object is the provision of a mine catcher with a projecting arm submerged in the water and having gripping jaws at the front which automatically close when they contact with the mine or anchoring cable thereof.

DISTILLATION OF LIQUIDS.—O. SÖDERLUND, and T. BOGERG, Clapham Park, London, England. This invention relates to the evaporation and condensation of fluids and particularly to the distillation of a dilute and easily obtainable solution such as sea-water for obtaining pure liquid therefrom. The object is to simplify and increase the heat economy of such process.

METHOD OF FORMING DIES FOR SIGN CHARACTERS.—M. CREIGHTON and A. W. DIXON, Rensselaer Falls, N. Y. Among the objects of this invention is to provide a method of making embossed letters in a much simpler manner than has heretofore been practised. Another object is to provide a method of making sign characters with raised portions through the use of male and female die members, the relation of the two dies being such that the raised portions of the letters will be provided with bevelled edges.

CHICKEN EXERCISER AND FEEDER.—W. H. COLLINS, Summit, N. J. This invention is characterized by a feed container having a controllable outlet for the feed which normally is so positioned as to be inaccessible to the fowls, the discharge of feed being obtained by the motion of a pendulum provided with the container for feed at the free end and accessible to fowls to peck at, when the fowls peck at the gauze material containing some inaccessible feed the pendulum is set into vibration thereby causing the feed to shake from the container.

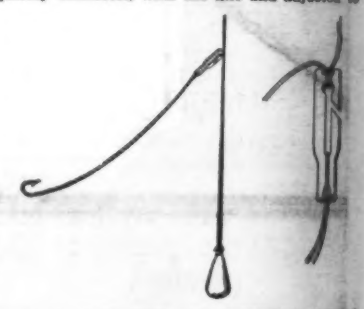
ICE CREAM PIPPER.—A. Mc D. LARROWE and A. L. KLINE, Canisteo, N. Y. The invention has for its object to provide a device wherein a handle member is provided having a cutting ring for permitting the cream to be scraped out when hard, and a holder of conical shape consisting of sections which are arranged to close against the ring and be closed by mechanism operated from the handle member.

VALVE FOR GASOLINE AND OTHER LIQUID FUELS.—F. CALDWELL, 7510 Cornelia Ave., Carthage, Cincinnati, Ohio. This invention relates to valve or controlling and commingling devices for use in connection with gasoline and other liquid fuels and especially where a nicety and accuracy of adjustment and mixing are required, the device is so constructed that in use, the valve controlling parts are in easy reach for adjustment by the operator for his ready control.

CAMERA.—H. G. MORDAUNT, care of Hotel Moreland, Cleveland, Ohio. This inventor has been granted two patents, the first No. 1,253,077 refers more particularly to a camera having a film winding apparatus and a film signal; the apparatus operating not only to turn the film from one position to another in order to bring up an unexposed portion of the film, but to move the signal from one position to another, the second patent No. 1,253,079 relates more particularly to cameras including a signal device which is set at each picture taking operation to notify the operator that that portion of the film then in proper position has been exposed, the signal so set is released to move to inactive position by the shifting of the film to bring the succeeding portion into position for exposure.

FILM SIGNAL FOR CAMERAS.—H. G. MORDAUNT, care of Hotel Moreland, Cleveland, Ohio. The object of the device is to provide for automatically indicating when a film has been exposed, and when the next succeeding portion is in position for exposure, the device consists of a member actuated by air pressure when the shutter mechanism of the camera is operated, it carries suitable indicia visible through the casing of the camera to indicate the exposure.

FISHING HOOK LEADER ADJUSTING TERMINAL AND OUTRIGGER DEVICE.—R. H. SMITH, P. O. Box 1042, Savannah, Ga. This invention is a device for attachment snoods to fishing lines, the same being adapted to be quickly connected with the line and adjusted to



VIEW OF MAIN LINE AND OUTRIGGER DEVICE

any desired position along the same. The device comprises a bar having its body provided with a central longitudinal slot and its ends with notches arranged in alinement with the slot, and an open oblique slot leading from the central one.

FILM WINDING DEVICE.—H. G. MORDAUNT, care of Hotel Moreland, Cleveland, Ohio. The inventor has been granted two patents. Generally speaking the mechanism provided by patent No. 1,253,076 includes spring operated gearing associated with the take-up roll of a camera, and normally held against operation by a suitable locking arrangement, for actuation of the take-up roll, when said locking arrangement is released, to rotate the take-up roll for the usual purpose. A further object is to provide mechanism which will enable the user to manually actuate the take-up roll whenever it is desired to do so. The object of the second patent No. 1,253,078 is to provide a compact and inexpensive apparatus which may be utilized either as an attachment for cameras now in use, or as a part of a completed camera in the first instance. The prime object is to simplify the construction of the first patent, and bring about equally effective results, and without the necessity of attachment to the film for the purpose.

Hardware and Tools

AUTOMATIC SPRINKLER HEAD.—F. J. FEE, 2232 Anderson Ave., Bronx, N. Y. The invention relates to automatic sprinkling devices for buildings, it has particular reference to means for reliably initiating the flow of water in the event of sufficient heat being generated in the vicinity of the device to melt the softer and weaker fusible metal used in this device, than is ordinarily used in similar devices.

Heating and Lighting

DAMPER REGULATOR.—G. WOLF, 419 E. 22d St., New York, N. Y. The invention has for its object to provide means for operating the damper shifting arm. Another object is the arrangement of in a damper of a metallic diaphragm bolted or otherwise rigidly clamped to the casing near its periphery. A still further object is to provide a metal diaphragm formed with openings designed to receive bolts provided in a casing, the openings of the diaphragm being so arranged as to receive the bolts of different casings, when differently arranged.

HEATING SYSTEM.—R. N. TRAER, La Crosse, Wis. This invention relates to steam heating systems, its object is to provide a construction whereby the return water may be caused to flow into the boiler regardless of the steam

(Concluded on page 198)

America has learned a valuable transportation lesson.

War conditions have taught us that the facilities of our railroads *can* be taxed beyond capacity. Depending solely on railroads for the transportation of merchandise resulted in congested freight yards and clogged lines. These created chaotic conditions—practically paralyzed business.

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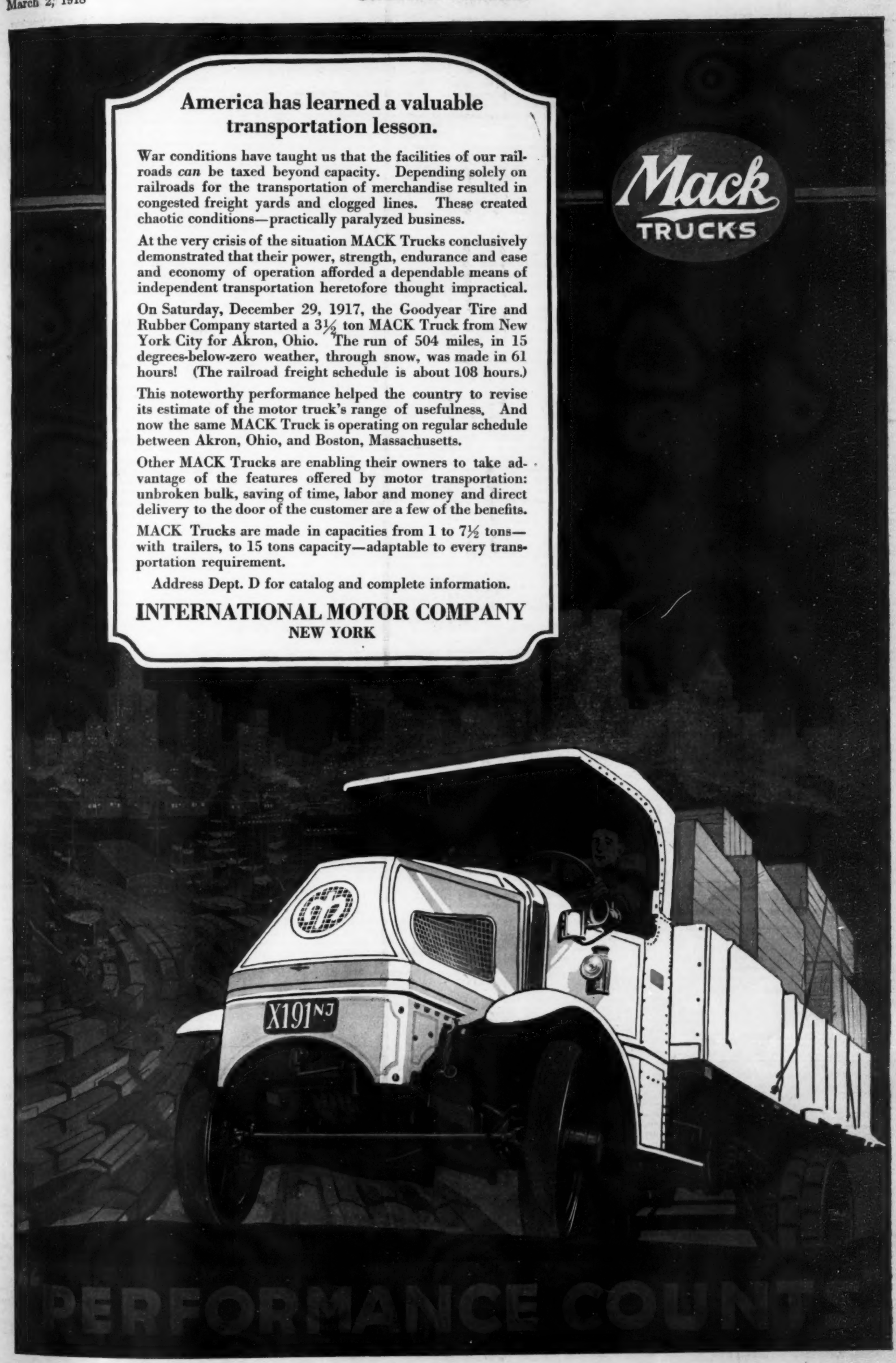


RECENTLY PATENTED INVENTIONS

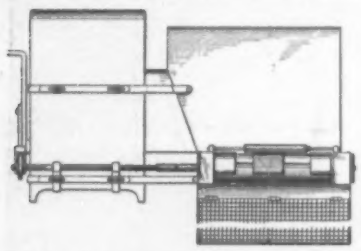
(*Concluded from page 196*)

pressure used. A further object is the provision of a regulator operated by the steam pressure for regulating the dampers and thereby controlling the draft for maintaining a certain even pressure of steam.

Machines and Mechanical Devices

COAL HANDLING JIG GATE.—M. H. REAP, address T. A. Donahue, Mears Bldg., Scranton, Pa. Among the principal objects which the present invention has in view are, to provide means for separating coal from base mineral associated therewith, to avoid waste of coal, to facilitate the operation of the mechanism for separating said materials, and to avoid unintentional increment of weight on operating parts of the separating mechanism.

CHECK INDORSING MACHINE.—R. H. GLADWILL, Ada, Okla. The invention relates to a means of mechanically indorsing checks, drafts, memoranda and the like. More particularly



A FRONT ELEVATION OF MACHINE, AS APPLIED TO AN ADDING MACHINE

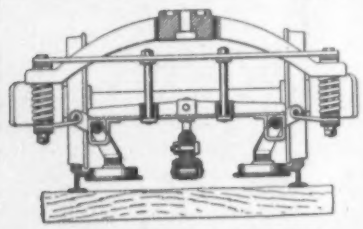
the invention relates to an indorsing machine adapted to be used in connection with an adding machine and involving a rotary stamp and a chute arranged to receive the checks directly from a leaf corresponding with the leaf in certain adding machines on which the checks are laid.

PRESSER FOOT LOCK.—E. W. BREINING, 422 Washington Ave., Bellevue, Ky. The object of this invention is to provide an electrically controlled mechanism for positively locking the presser foot of a cloth cutting machine when the machine is in operation. The locking mechanism comprises an electro-magnet having secured to each end of its core a pawl, the pawls extending laterally from the magnet and having teeth at their outer ends for engaging the teeth of a rack bar.

CABINET TALKING MACHINE.—H. D. DARLINGTON, R. D. No. 12, Dayton, Ohio. An object of this invention is to provide a cabinet of novel construction in which sound pipes are utilized in connection with the amplifying chamber of the cabinet. These pipes are of various lengths and consequently are adapted to produce different tones. Another object is to provide a cabinet which is made of metal.

Railways and Their Accessories

DEVICE FOR PREVENTING DERAILMENT.—E. CASTANHO, Rua Liberdade 64A São Paulo, Brazil. The invention relates to means applicable to a railway truck to prevent derailment, and particularly relates to a device in



A TRANSVERSE VERTICAL SECTION

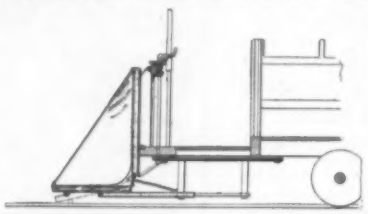
which guard wheels are adapted to be positioned to turn on vertical axes and engage a lateral nervure or rail on the track. An object is to provide means to automatically lower or raise the guard wheels to and from the operative position, and at a crossing track the device may be applied to standard railway trucks without material alteration to the truck.

TRAIN CONTROL.—J. W. GRIFFIN and F. M. MCHUGH, 814 Amsterdam Ave., New York, N. Y. An object of the invention is to provide an automatic contrivance controllable from the railway signals, and whereby a train will be prevented from passing a signal when the right of way is closed. A further object is to provide a control whereby the train cannot be started until the signal indicates a free way. The control is adapted to intercept the flow of energy to the prime mover of the train and also release the pressure in the train line independently of the engineers valves.

LOCOMOTIVE DRIFTING VALVE.—A. A. MEISTER, J. W. SURLES and E. F. BOYLE, address A. A. Meister, Supt. Fuel Bureau, 708 S. P. Building, Houston, Texas. The present invention relates particularly to a device for admitting saturated steam from the boiler to the steam chamber of the valve chest and cylinders while the locomotive is running with the main steam throttle closed. The device is designed to be used in connection with superheated locomotives, its use discards the usual relief valve, which admits air into the cylinders, destroys the lubrication, and causes rapid heating of the valves and piston rigns.

POWER TRANSMITTING ATTACHMENT FOR AUTOMOBILE WHEELS.—W. ROBERTS, R. D. No. 3, Springfield, Ohio. This invention relates to an attachment adapted to be applied to the tire of a driving wheel of an automobile whereby power can be derived therefrom for any useful purpose while the automobile is standing and the rear axle is raised, it can be applied to wheel tires of any diameter, shape or style.

RAILWAY CAR FENDER.—T. DOUGHERTY, 526 59th St., Brooklyn, N. Y. This invention relates to safety appliances for railway cars, and has particular reference to fenders carried on the front ends for the purpose of reducing the danger



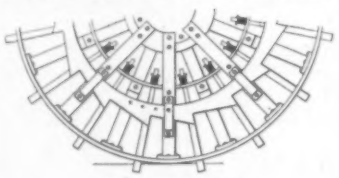
A SECTION SHOWING PARTS IN POSITION, AND INDICATING IN DOTTED LINES DROPPED POSITION

due to pedestrians who chance to be in the path of movement of the cars. An object is to provide a fender comprising movable pad portions adapted in one position to receive the impact of an obstacle and reduce the extent of injury, and in another position to be folded and housed beneath the platform of the car.

Pertaining to Vehicles

SPEED RECORDER.—R. ERDLE, 1220 45th St., Brooklyn, N. Y. The invention relates to speed recorders having a clock driven member and a finger marking on the peripheral face of the said member and controlled by the speed of the vehicle machine or other device on which the speed recorder is used. The finger on the clock driven member is rendered visible for a certain length of time and then obliterated to restore the indicating means to normal blank condition.

LUG FOR TRACTORS.—J. SIBILLE, Amandville, La. The prime object of the invention is to provide a tractor wheel equipped with lugs adapted to be adjusted for hard or soft roads with



A SIDE ELEVATION

facility, whereby to save time in changing the character of the wheel. In carrying out the invention use is made of separate tractor lugs mounted on the wheel to project more or less beyond the periphery of the wheel, or to be retracted whereby to present little or no projection beyond the tread of the wheel.

HEADLIGHT.—E. H. WERBNER, care of Schroeder Headlight Co., Inc., Evansville, Ind. The invention has for its general object the construction of a headlight, with an adjustable mounting for the lamp whereby the same can be positioned in the focal center of the reflector. A more specific object is the provision of a lamp mounting which is located outside the reflector and includes means whereby the lamp can be adjusted in all directions.

HEADLIGHT LENSES.—G. D. SAILER, M. H. MILLER, T. G. STOUGH, address H. V. Rowan, Attorney, 117 3d St., Jeannette, Pa. An object of the invention is to provide a headlight lens which will eliminate the dangerous glare and which will render the light soft and mellow, to provide a device by means of which the glare may be eliminated without reducing the amount of light, to provide a lens easy to clean, and not easily liable to be broke.

DEVICE FOR CONTROLLING SHOCK.—C. B. BILLINGHURST, 303 Dakota Ave., Pierre, S. D. The invention has for its object the provision of mechanism especially adapted for use in connection with motor vehicles, for eliminating shock and jar resultant from the movement of the vehicle over the road. It consists of an inner and outer frame one connected to the body of the vehicle and the other to the springs. Each frame is provided with flexible non-metallic hangers connecting the frame to downwardly projecting standards on the other frame.

VEHICLE FRAME SUSPENSION.—T. WILSON, Indio, Cal. The invention relates to suspensions for four-wheel motor vehicles, its object is to provide an arrangement of springs whereby a jolt is cushioned and a rebound absorbed. A further object is to provide a suspension in which the springs are connected at one end with a suspension bar and at the other with a body either directly or by coacting springs.

Designs

DESIGN FOR AN EMBLEM.—W. B. COLE, care of Cary & Carroll, 59 Wall St., New York, N. Y. This ornamental design consists of the representation of a conventionalized garter, the space enclosed thereby being divided into three sections of equal area, the two upper sections bearing respectively the letter "B" and "W."

DESIGN FOR A BADGE, CHARM, STICK PIN, FLAG, SIGN, FOB, OR EMBLEM.—B. R. JOLLY, 51 Maiden Lane, New York, N. Y. This ornamental design represents a shield showing the stars and stripes of the United States flag surmounted by a cannon and crossed sabers

NOTE.—Copies of any of these patents will be furnished by the SCIENTIFIC AMERICAN for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

NEW BOOKS, ETC.

THE WORLD PERIL. America's Interest in the War. By Members of the Faculty of Princeton University. Princeton: Princeton University Press, 1917. 8vo.; 245 pp. Price, $1 net.

The one thing furthest removed from the mind of the American is the idea of his country dominating, and dictating to, the world; this ambition being outside his own mental make-up, it is one he is loth to attribute to others; perhaps the greatest step toward unification of the country is to convince these doubters that Teutondom will be satisfied with nothing less than the enslavement, first of Europe, then of America. President Hibben makes this task of enlightenement clear in his introduction, and the members of his faculty contribute a series of papers with this end in view. These papers deal with the conscientious objector, the attacks on democracy and international law, the United States' relationship to South America, to the Far East, and to the world balance of power, and international freedom and world peace. To any who have not yet got the obsolete idea of our isolation and aloofness out of their heads, to all who still obstinately ask why we need concern ourselves with the European chamber of horrors, this excellent work, instinct with marvelous insight and powerful not by any hectic quality of appeal to the emotions but by reason of its grasp upon facts and their significance will plainly show them that the battle-front in France is the Eastern frontier of America, and that our boys are fighting there with our Allies in order that the battle for freedom shall not ultimately take place upon our own invaded soil, with no friendly hand to assist us. It is an exceptionally keen and comprehensive survey of the situation and of the unmistakable bearing that has upon our own right to life, liberty and the pursuit of happiness.

THE DIARY OF A NATION. The War and How We Got Into It. By Edward S. Martin, of *Life*. Garden City, N. Y.: Doubleday, Page & Company, 1917. 8vo.; 407 pp. Price, $1.50 net.

Week by week, since the war began, *Life* has published an article—a sort of log, dealing with the conflict particularly as it affected our own ship of state, and reflecting the mental attitude of the crew. It is seldom that jottings like these prove worthy of permanent form, but none can deny that worth to Mr. Martin's pungent and prophetic Diary. The formation of American opinion as affected by the successive bewildering developments of Teuton insanity and French sacrifice is skillfully followed, and the high-flown language of diplomacy is reduced to the racy sincerity of our everyday tongue.

AUDUBON THE NATURALIST. A History of His Life and Time. By Francis Hobart Herrick, Ph.D., Sc.D. New York: D. Appleton & Company, 1917. 8vo.; 1,000 pp.; illustrated. Two volumes. Price, $7.50.

The publication of this sumptuous work is decidedly one of the great literary events of the year. The author's fortunate discovery of some old documents, in Coueron, France, clears up the mystery of the naturalist's birth, which occurred not in Louisiana but in Les Cayes, San Domingo. We are given more than a glimpse of his father's extraordinary career; as a fighter on land and sea, his adventures are amazing; wounded in battle and taken prisoner to England at the age of 14, serving in the French navy, captured again and imprisoned at New York, commanding at the battle of Yorktown, and finally amassing a fortune as a San Domingo planter and slave-trader, his biography reads like the wildest fiction. The son lacked his father's qualifications for trade; venture after venture in America failed, but all the while he was accumulating an astonishing fund of knowledge relating to our fauna, and at last denoted his life to the imperative call of nature. In 1826 he exhibited his drawings in England; the following year sees him lionized in London; after a further series of disappointments and vicissitudes the "Ornithological Biography" is published. His great work was of course "The Birds of America," in four volumes, with 435 colored plates carrying 1,055 life-size figures of his feathered friends. The author, himself a biologist and a student and lover of birds, must have needed all his natural sympathy with his subject to sustain him in his unwearying efforts. His arduous search for original material has been crowned with the most complete success; his two volumes are packed with the fac-similes of interesting documents, portraits of Audubon, his family and his friends, and reproductions from his original drawings, many of them of hitherto unpublished sketches and water-colors.

A JOURNAL FROM OUR LEGATION IN BELGIUM. By Hugh Gibson, Secretary of the American Legation in Brussels. Garden City, N. Y.: Doubleday, Page & Company, 1917. 8vo.; 372 pp.; illustrated from photographs. Price, $2.50 net.

Another noteworthy contribution to war literature is this official story of the tragedy of Belgium, these vivid day-by-day jottings set down with all the power of fresh emotion generated in a storm-center of impending disaster. The tense life of Belgium during the first months of the war is depicted as only a man so familiar with its undercurrents could depict it. Just before the outbreak of hostilities Mr. Gibson had tired of his quiet surroundings and had asked to be sent where there was opportunity for greater activity! But on July 28th he writes, "Well, the roof has fallen in." From that time his yearning for activity was more than satisfied. The "hectic days" of an invaded country carry the reader on in a breathless rush; King Albert's great speech of defiance meets with an unanimous, an uproarious response, and Belgium is embarked upon that desperate, foredoomed resistance that placed honor above all else, and held back the German flood until French dikes could be improvised to stay it. The impressive, silent entry of the German troops takes place before our eyes—an overwhelming show of discipline, efficiency and equipment. Some of the succeeding famous—or infamous—proclamations are shown; the indefatigable work of our Legation, although modestly described, should make us very proud of its members; the author's intimate dealings with the Germans and his many opportunities of observing King Albert, often under fire, lend further interest to pages surcharged with adventure, and sidelights are thrown upon many important happenings, of which the Edith Cavell case may be cited as an example. No matter what you may have read of Belgium in the war, new items of information will meet your eye on almost every page; it is a book that no true American may ignore.

THE WAR MANUAL. By Lt.-Col. C. C. Anderson. New York: The Macmillan Company. 8vo.; Vol. I, 250 pp., Vol. II, 540 pp.; illustrated. Price, $4 per set.

This is an English publication, crammed from cover to cover with the principles and practice of modern warfare. The first volume explains strategy, discussing plans of campaign, lines of operation and bases, and natural and artificial obstacles in the theater of war; it presents the laws and usages of war on land and cites the Defence of the Realm Acts; there is a great deal of general information concerning the British Empire and foreign nations, and a section on first aid to the wounded. The second volume is an able handling of tactics, fortification and reconnaissance; it discusses military formations under the heads of cavalry, artillery and infantry; guards, sentries and saluting; orders; intercommunication; bridges and the passage of water; hasty demolitions; the strategical concentration; marches; the attack and the defense. The work is compiled from authoritative sources; much of the material should be of service to our own officers, and the private may find in it the promise of that well-known saying, "Every soldier carries a Field-Marshal's bâton in his knapsack."

NEW FIELDS FOR BREWERS. And others Active in the Fermentation and Allied Industries. Edited by Carl A. Nowak, B.Bc., F.S.C., St. Louis, Mo.: C. A. Nowak, 1917. 8vo.; 300 pp.; illustrated. Price, $3.

The brewing industry, and with it a long line of subsidiary activities, is facing a crisis that can be met only by a reconstruction and extension which shall employ the vast invested capital to new uses; and since the brewing plant and equipment do not lend themselves readily to other manufacturing pursuits, the problem is a serious one. A well-qualified writer on this subject here gives the trade a wealth of practical suggestion, taking up the possibilities of low alcoholic beers, non-malt beverages and fruit juices, yeast, vinegar, malt preparations, breakfast foods, commercial feeding stuffs, the dairy industry, and industrial alcohol. The proffered aid is well-timed, and characterized by a grasp of the situation that is reflected in the soundness of the suggestions.

FIELD BOOK FOR MACHINE GUNNERS. By Captain Edward B. Cole, U. S. Marine Corps. Kansas City, Mo.: Franklin Hudson Publishing Co., 1917. 16mo.; 82 pp.; illustrated. Price, $1.

Machine gun practice as developed by English, French and German authorities has been condensed by the author into a pocket-size primer for the American soldier. It describes the various types of this arm and conveys a working knowledge of organization, maneuver and fire, and of the assaults and defenses of trench warfare, together with drill signals and the duties of non-commissioned officers and gun crews. There are tables of elevations, ordinates, and corrections, and it is hard to conceive of a handbook that should pack more really pertinent information into any smaller space and yet have it so thoroughly understandable to the men who are learning to handle the "devil's watering-pots" of Uncle Sam.

AN ELEMENTARY OUTLINE OF MECHANICAL PROCESSES. By G. W. Danforth, U. S. Navy. Annapolis, Md.: The United States Naval Institute, 1917. 8vo.; 423 pp.; illustrated.

The subject of mechanical processes has a very wide practical interest, and while this text addresses itself particularly to the instruction of midshipmen at the United States Naval Academy, where the author is instructor in the Department of Marine Engineering and Naval Construction, it should find a wide appreciation among students in general. It concisely describes the properties of materials and the methods of producing them, with just sufficient detail to enable the student to grasp methods and principles quickly and surely. It conducts him through the operations of metal manufacture from ore to finished product, and visits many of the great industrial organizations in search of information that is eminently practical and up-to-date. The reader is thus given the benefit of knowledge that has been perfected only after great expenditure of time and money, and the utmost application of patience and perseverence; he learns the distinctive features of building and repairing plants, of the pattern shop, foundry, boiler shop, and various other buildings and departments of modern industry; special processes are explained to him, and an appendix contains valuable reference material, including tables. Simply-worded and comprehensive, the work should have a wide field of usefulness before it.

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Look at the radiator on this car.

Notice the tightly closed shutters barring out the cold, helping to keep the engine and jacket water warm.

This car is equipped with a Harrison Radiator with automatically controlled shutters.

The Harrison Radiator Shutter saves gasoline and oil—increases engine efficiency—makes starting easier.

It saves wear by eliminating the racking of parts from imperfect carburetion and ignition.

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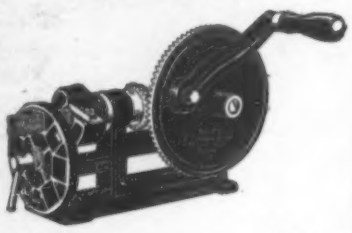

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A tool for Carpenters, Cabinet Makers, Pattern Makers, Furniture Manufacturers, in fact for any one interested in wood working.

It will not only cut dowels of varying sizes and lengths to perfect dimensions, but with it one can also form rods of practically any length.

Ready made or stock dowels have a tendency to warp and shrink, making them very unsatisfactory to use where a close fit is desired.

With this machine the workman can cut his dowels when he is ready to use them and furthermore of the same material as the wood being worked.

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Additional cutter heads with cutters ¼, 5/16, 11/32, ⅜, 7/16, ½, 9/16, 11/16 and ¾ inches can be furnished if desired.

A workman whose tool equipment includes one of these machines and a Stanley Doweling Jig can make doweled joints with surprising quickness and accuracy.

Price, with ⅜ inch cutter head, $8.50.

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Gas Warfare

WHEN the Germans introduced noxious and poisonous gases as a weapon of attack they evidently thought they had a monopoly which they could employ when it suited them, and that the allies could not retaliate in the same way, so, when the French and the British in their turn smothered their trenches with similar suffocating clouds they were fully as unprepared as the allies had been.

Credit must be given to the Huns for the ingenuity of the scheme, but apparently they did not appreciate the tremendous possibilities of the new method of attack, for if they had they would have made their preparations on a much greater scale, and introduced it along the entire front at the same time; but they made the mistake of trying the experiment on only a small section, and although they succeeded in making a clean breach through the English lines at that point, it was so small in extent that it was possible to close it again before any material results had been gained. And before the Germans realized their advantage the allies had adopted the new weapon, which is now very extensively employed by both contending forces.

The subject is much more extensive than has been generally realized from the occasional references that have been made in the reports. At least twenty different substances have been used by the Germans (for obvious reasons the Allies have made no public statements as to what they are using), and these are described in an article in the current issue of the SCIENTIFIC AMERICAN SUPPLEMENT, No. 2200, together with an account of the methods employed to scatter them by gas clouds, shells and hand grenades, and how these attacks are met by various kinds of masks. It is the most complete description of every feature of gas warfare that has yet appeared.

The Current Supplement

AN article on *The Technical History of the Airplane*, in the current issue of the SCIENTIFIC AMERICAN SUPPLEMENT, No. 2200, for March 2d, will be welcomed by the general reader, as it explains simply and clearly many of the essential features of flying machines which everyone wishes to know about, but which are usually only to be found in highly technical papers. *Drying Vegetables a New Conservation Move* calls attention to a process that has heretofore been but little used in this country. It is illustrated by several photographs. *Are Concrete Ships Desirable?* calls attention to some of the objections to, and practical difficulties to be encountered in the construction of these much advertised vessels. *Modern Margarine Technology* deals with matters pertaining to a widely used substitute for butter. *The Evolution of Time-Marking Devices* describes and illustrates a number of ancient methods employed before clocks were invented. *The Divining Rod*, which tells interestingly the history of water witching is concluded in this issue. *The Development by X-Rays of Two New Fields* tells how the radiographer has been able to throw light in unexpected places, and is accompanied by explanatory diagrams. *Gas Warfare* describes very thoroughly the methods employed in this new method of warfare, and the materials employed. There are a number of other articles of general interest.

New Methods in Bulkhead Construction

(Concluded from page 183)

with non-parallel sides had to be used. Wherever interlocks were not made, auxiliary piles were driven back of the steel sheeting, and these will probably stop all leaks. At any rate, this was the practice in rounding the curve. The standard shape known as the I-beam was put down at 1-yard intervals along the water side of the piling. The I-beam has two double flanges. One of these was interlocked with the steel piling. The function of these beams is to lend stiffness and strength to the steel wall as a whole.

Steel was also employed in a tie-back system to hold the wall upright in its proper position. The wall is held at the bottom by being driven into the rock, both sheet piles and I-beams having their feet below the upper surface of the hard material. Substantial restraint is needed at the top. Up to the water level, we might, perhaps, expect a more or less balanced condition due to the pressure of the water on one side and of the filling on the other. However, we can hardly calculate with precision the pressure of the filling. Ordinary sand has a specific gravity of two or thereabouts; so that, if it acts as a liquid, there would be a heavy excess pressure tending to burst the steel wall towards the river. Even if the steel should be cut off at the water level, safety would require that it be tied back to resist any excess pressure from the filling. At Jacksonville, however, the fill is carried up several feet higher. As this was to be held in position by the steel wall or at all events by a wall dependent upon the piling and I-beams for its stiffness, there was an additional reason for the tie-back system. At low water, a strong outward pressure was to be expected, and in the absence of tying this pressure would have no resistance on the water side.

The tie-back system involves the second use of steel on this job. It consists of short steel wales, set in horizontally between consecutive I-beams on the water side and held against the sheeting by rods running back to a wooden anchorage buried in the soil back of the steel piling. This system of steel-work is located at about the water level, but is protected in various ways.

It will perhaps be readily understood from the foregoing that the Jacksonville work consists essentially of a fill held in place by a steel wall tied back to a buried anchorage of wood. This is the case; but there are other matters of interest. The steel wall is faced with concrete. This facing is more than thick enough to cover the I-beams and walls. In addition, the concrete is carried on above the steel and forms a parapet covering the metal, back and front.

The riverward pressure of that portion of the fill which lies above the water line is reduced by a relieving platform. This is a wooden floor resting on wooden piles back of the bulkhead wall and parapet. It reduces the pressure because it supports a large part of the upper portion of the fill. That is to say, we are permitted to assume the existence of an inclined plane sloping up and back from the water level, this plane being such that no forward horizontal pressure is exerted by the portion of the fill between it and the platform and that whatever forward pressure exists comes from the fill above this plane. This plane is located approximately at the angle of repose of the material on the platform.

It will now be understood that there is a considerable total of both wood and steel construction back of the steel-concrete bulkhead—tie rods, anchorage, platform, supporting piles. But all of this is buried in the fill. The wood is safe from the teredo. The wood and steel will, all of it, probably be perpetually under water, inasmuch as we may assume that the water line inside the fill will never drop all the way to the low water level. The inner surface of the sheet piling will be perpetually submerged, except what stands above water imbedded in concrete.

Altogether, we have in this construction at Jacksonville an interesting effort, in the interests of economy, to take advantage of the possibilities and to beat teredo, corrosion and decay by submergence and protective covering. Ii it proves successful in the long run, then we shall undoubtedly have in the future other and still larger examples of such combinations of wood, steel and concrete.

Extracting Stories from Stones

(Concluded from page 187)

varieties of limestone will show none at all—in other words, the specimen wears out before the test is completed.

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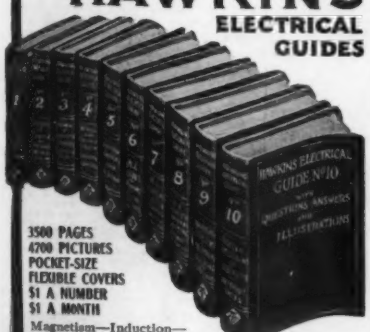

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hammer, which weighs about five pounds is from a greater height than the previous blow. The machine, once adjusted, is automatic.

To make the test, a cylinder of rock, similar to that used in the hardness test, is carefully ground to one inch in length. It is placed on the anvil of the impact machine in such a position that the rounded end of the hammer rests exactly in the center of the end of the cylinder of rock. The machine is adjusted and started and the hammer rises and falls upon the specimen. The first blow is from a height of about one-half inch, the second blow falls from a height of about one inch, the third blow from a height of 1½ inches, and so on until the rock fails. The height of the blow which breaks the specimen is recorded as the toughness of the material, an average of two determinations being taken. Soft stones break at two or three, while very hard rocks will resist a blow of 25 or even 30 inches, though this is rare. The test is an excellent index of the capacity of rock to resist the impact of the blow of iron shod hoofs.

Stones forming the foundation of a road perform the function of supporting the weight and provide part of the drainage. Stones forming the surface of the road not only do these things but take the abrasive wear, which produces the powder which, with water, forms the bond of a water bound macadam, holding the stones in place. To determine the ability which wet rock powder has of binding larger fragments together into a mass, the cementing value test is made. The rock to be tested is broken into small pieces in a crusher and then ground to powder in a ball mill. This apparatus is a revolving hollow iron case in which two shot made of steel five inches in diameter and 20 pounds each in weight, are placed. About one pound of rock crushed to pea size is placed in the ball mill with a small amount of water, the mill revolved 5,000 times at 30 r.p.m. producing a dough-like mass of rock powder and water. In a special machine designed for the purpose, this dough is molded into little cylindrical briquettes one inch long and the same diameter. The pressure used to form them is nearly 2,000 pounds per square inch.

The briquettes are very carefully dried for 20 hours in the air, and for four hours at 212° F. in an oven, and finally cooled in a desiccator. They are then tested in an impact machine which delivers successive blows of equal force, the hammer dropping from a height of about one-half inch. A record on sensitive paper is made by the machine showing the number of blows struck, the total of which at the failure of the briquette is its cementing value. The variation in the results is great, running from nothing in the case of certain quartz which has no cementing value whatever to several thousand blows in the case of certain high binding clays. On account of the many variables in this test an average of tests on at least five briquettes is considered necessary for accuracy.

The laboratory does not confine itself to tests of rock. Cement, used not only in road construction, but for bridges, drains, culverts, etc., is carefully tested. The method is simple—the cement is made into briquettes of a rough figure 8 shape, in molds, by hand, and when hard and dry is pulled apart in a tension machine in which the exact force necessary to break the briquettes is applied by pouring shot into a receptacle. The weight of the shot determines the force required to produce failure of the briquette.

Sand is analyzed mechanically, to find its proportion of various sizes of grains, by passing through a succession of sieves with different sized openings. The percentage retained by each sieve is obtained by weighing the sand.

Many different tests of bituminous products are conducted. Perhaps the most interesting from a road builder's standpoint is that of the determination of the penetration of asphalt, both on account of the value of the results and the delicacy of the method.

The specimen to be tested is placed on a tripod in a constant temperature bath, electrically heated and controlled. When

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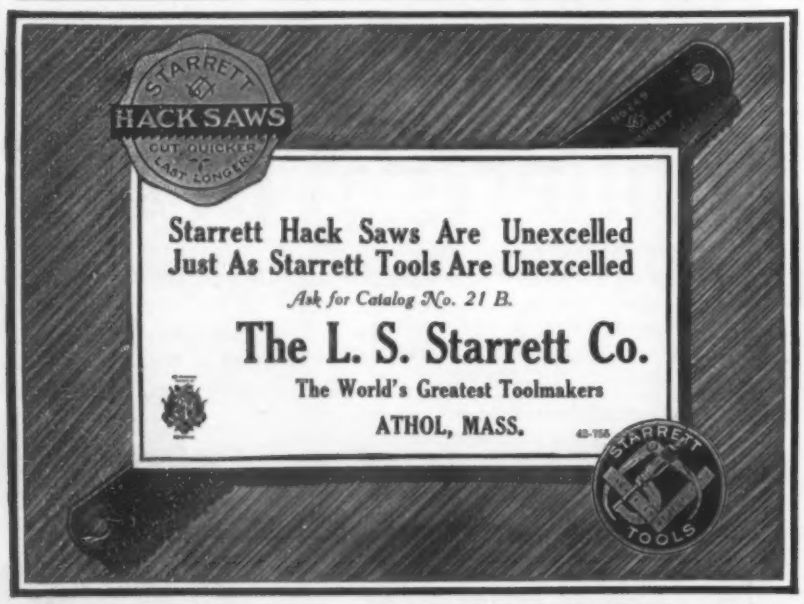

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the specimen has been in the bath 1½ hours, insuring a uniform temperature throughout, the point of a standard needle is adjusted so that it is just in contact with the surface of the sample. The penetrometer plunger is weighted so that the weight on the needle is 100 grams and can be released by pushing the button on the arm. The position of the needle is read on the dial. After releasing the needle and permitting it to penetrate the sample for 5 seconds by the metronome, a second reading is taken and the difference between readings is the penetration of the sample.

In making the fixed carbon determination for petroleum or asphalt products, a one-gram sample of the bituminous material is heated in a platinum crucible weighing about 25 grams, and having a tightly fitting cover, using a Bunsen flame fully 20 cms. high when burning freely. The bottom of the crucible is 6 to 8 cms. above the tops of the burner. At the expiration of 7 minutes the crucible is cooled and weighed, again ignited until all carbonaceous matter has been consumed, then cooled and weighed. The percentage of ash-free coke based on the content of organic matter in the sample is calculated as the percent of fixed carbon.

To determine the softening point of bituminous materials a brass ring $\frac{5}{8}$ inch diameter, ¼ inch deep, with a $\frac{3}{32}$-inch wall is filled with the material to be tested and suspended one inch above the bottom of a 600 Cc. beaker containing 400 Cc. of water at 5°C. A steel ball $\frac{3}{8}$ inch in diameter is placed in the center of the ring and a thermometer placed with its bulb within ½ inch of the ring and at the same elevation. The bath is heated so that the temperature rises 5° C. per minute and the softening point is taken as the temperature at which the specimen has dropped one inch.

All these tests, and many others, are made without charge for interested inquirers, when possible. The service furnished by the testing laboratory is distinctly a first aid to road building communities or people, and designed to aid in the making of the right kind of road of the right kind of easily available material. In general, practically any samples of road building rock will be tested free of charge provided the samples are submitted in accordance with the printed instructions, which are sent on request.

The office desires to keep a record of the actual wear on roads built of materials tested, and to make its tests of the widest possible value, not only to the parties directly interested but in the gathering, collating and making available of as much information regarding road materials as can be obtained. Hence the need for the simple restrictions as to sizes of rock sent, weight, methods of shipping, etc., in order to secure that uniformity of samples submitted which will make for coherency of result.

Those interested in road building should write the Director of the Office of Public Roads and Rural Engineering, Washington, D. C. for full information as to how these tests and the free service may be obtained.

Motor- and Horse-Drawn Tile Ditching Machines

(Concluded from page 193)

On the front end is a heavy shoe that loosens up the earth, which is forced backward until it strikes the elevator by which it is delivered to the table just back of the operator and removed to one side. The rear wheels furnish the power to propel the elevator chain. The depth at each cut is regulated by a hand wheel which in turn controls the rack and pinion seen in front of the man standing on the machine.

This machine costs $450 and if carefully operated is capable of digging 50 to 100 rods per day. The ditch usually requires hand finishing, and the grade must be carefully tested before the tiles are laid.

Figure 3 shows one type of horse-power ditcher. This machine is built on somewhat the same plan as that of the traction ditcher just described. The large wheel cuts a trench 11 inches wide and up to 4½ feet deep. The flanges on the edge of the wheel penetrate to a depth of three to six

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inches; the shovel at the rear loosens up this earth which is then carried between the endless belt and the wheel up to the top of the machine, when it is dropped upon a conveyor and carried to one side of the trench. Only from three to six inches of earth can be removed at one time; this necessitates going over the ground several times before the desired depth is reached.

Four horses are required to draw this machine—two on each side of the trench. The operator controls the depth of cut by means of a rack and pinion operated by a large hand-wheel. The grade cannot be fixed as accurately as with the traction ditcher, though by carefully checking the work with a level as the proper depth is approached, a good operator can establish a satisfactory grade. It is usually necessary to use a hand scoop to prepare the trench finally for the tile, since a few crumbs will always fall into the ditch and there will be uneven places which will require some attention.

This machine costs about $350. It is capable of digging 50 to 75 rods of ditch a day under reasonably good conditions. It works best when the ground is a little wet. If the soil is too dry and hard the weight of the machine is not enough to give the desired penetration. It will not work well in stony soil. If large stones are encountered it is necessary to lift the wheel and resort to hand work to remove the obstruction. The same thing is true, however, of the traction ditcher.

Figure 4 illustrates still another type of horse-drawn ditcher. This is nothing more nor less than a huge plow with narrow extension moldboards on either side. The front wheel runs in the trench. The point of the heavy blade loosens the soil which is then forced up the large moldboards by the forward action of the ditcher. This machine requires rather favorable conditions for its successful use.

The chief merit of these horse-drawn ditchers lies in the fact that they are inexpensive and thus within the reach of individual farmers. Or, if desirable, two or more neighbors may buy a machine in partnership, combine their forces and help each other in ditch construction. Work can be done much more rapidly than by hand and as a result their wide use will unquestionably lead to the installation of many drainage systems that would not otherwise be touched if hand work were relied upon.

The Patent Office Society

(*Concluded from page 194*)

scientific, technical and legal fields and where views can be exchanged between these experts and the men upon whom are placed the burden of granting or refusing patents.

In line with its purposes, the Society has considered the serious condition which has always confronted the Office but which has been accentuated particularly the last few years. In the past five years more than one hundred and thirty examiners out of a total of 360 have resigned. On account of the inadequate salaries in the service and the greater inducements offered in private employment, the office force is in a continuous state of flux, to the detriment of a proper *esprit-de-corps* and of efficiency of personnel, and striking at the very root of the Patent Office's value. The Society has been the means of ascertaining that the average salary of those resigning for the first year after leaving the Office was at an increase of 30 per cent, and that the average income of those who have been in private practice more than three years increased more than 143 per cent. These figures and percentage of resignations are their own comment.

In compliance with the objects of the Society, and with the endorsement of Secretary Lane and Commissioner Newton, it has invoked the aid and assistance of the National Research Council, in allusion to which the SCIENTIFIC AMERICAN has devoted editorial space under the caption "The Nursing Place of Industrial Evolution," in its issue of February 9th, 1918. Through the efforts of the Council, a composite committee has been appointed to investigate the needs of the Patent Office and to propose remedies therefor comprising, it is understood, the following eminent scientists, inventors, and authorities on patent law and procedure: Leo H. Baekeland, Wm. F. Durand, Thos. Ewing, E. J. Prindle, Fred P. Fish, Robt. A. Millikan, Michael I. Pupin and S. W. Stratton. This committee will probably meet in Washington shortly, and its proceedings are confidently expected to initiate a movement of reform which will add considerably to the effectiveness of the patent system and thus promote immeasurably its service to American industry and society.

The Society hopes by thus enlisting the coöperation of this powerful body of high-minded and influential men, to create a public opinion favorable to its objects. The Patent Office is inadequately equipped for its great service, it has been woefully neglected by the law making powers, and its needs are urgent if not critical. No other institution stands for what has made America preëminent as the Patent Office, for in no other pursuit have her contributions been so notable as in the sphere of invention. With a cause so worthy of success, and a successful issue so beneficial to the patent system and to the country, this organization looks forward confidently and hopefully.

French War Breads

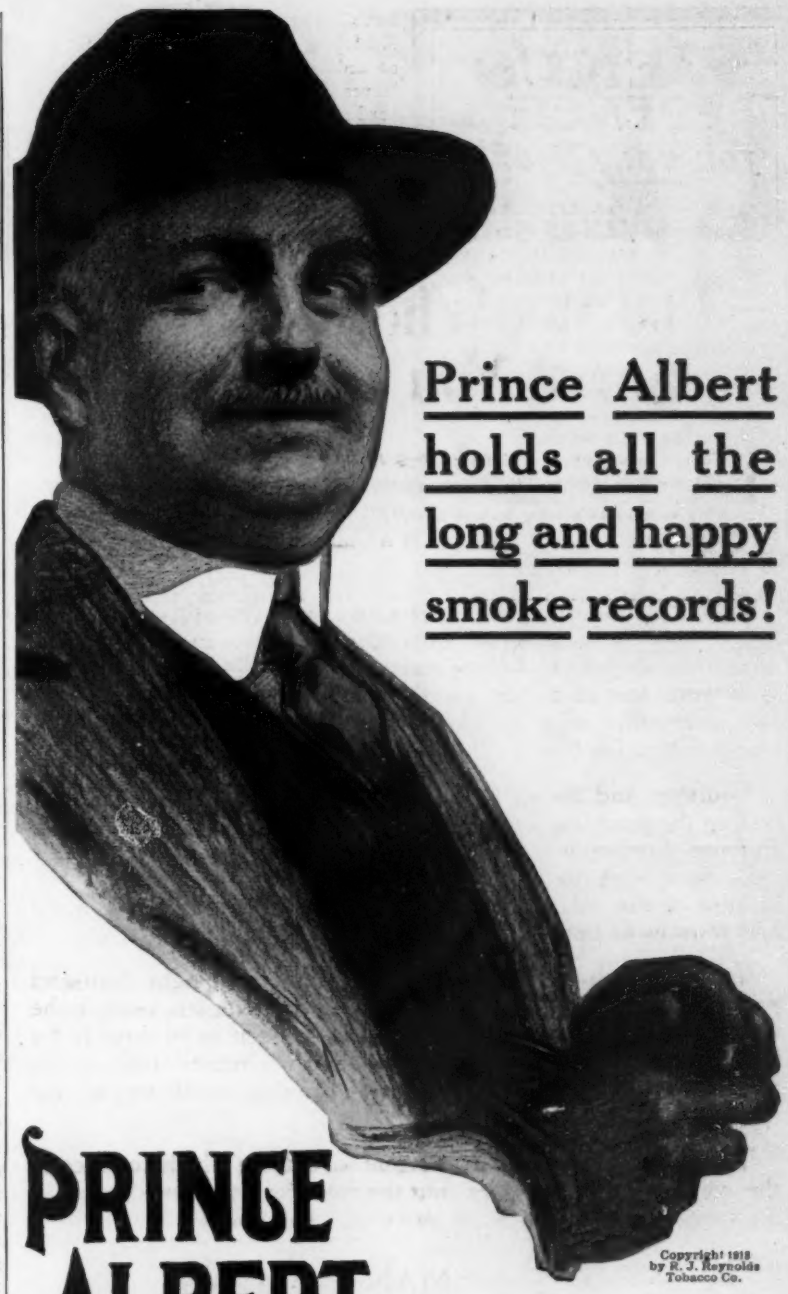
FRANCE is not as dependent on other nations for breadstuff as is England, for instance. Before the war, the French wheat production was about the same as the wheat consumption, athough French people are great bread eaters. However, on account of the shortage of farm hands, the crops of the war years decreased notably. As the importations are very difficult, it was necessary to save a part of the wheat consumption.

First, the making of fancy bread was prohibited: the Parisians had to give up the "croissants" they were so fond of for breakfast. Then the millers had to issue only common grade of bolted flour, in order to produce more flour and less bran with a certain amount of wheat. The bakers were ordered not to sell new bread, but only bread baked the day before, another hardship for the Parisians, accustomed to have each morning bread made during the night. All these measures did not sufficiently reduce the price and consumption, consequently, in several places the baking process has been changed.

In Cherbourg, the military bakery now uses sea water instead of soft water: in this way, they save the salt usually added to the water when kneading, and produce a bread which can be kept a longer time without getting hard. In many other places, they use lime water instead of ordinary water to wet the flour: that enables them to utilize a large proportion of "rebulet," "recoupe," or other mill products intermediate between flour and bran. These materials, being acid, would disturb the process of fermentation if part of their acidity was not neutralized by the lime. (In France, yeast is exclusively used, baking powders being unknown). As lime is very little soluble in water, the use of lime water cannot possibly harm the health of the consumer. Instead of lime, it was suggested to use saccharate of calcium, an excess of which will be harmless; but that was not adopted because of its supplementary cost.

In some parts of central France, where they make a specialty of cultivating potatoes, the bakers revived old methods devised a century ago by the famous Parmentier, to prepare potato bread. The Parmentier process, established after numerous experiments, does not require the use of potato flour, but allows the utilization of potatoes simply cooked in water. The tubers being peeled and mashed, the "puree" so formed is kneaded with an equal weight of regular dough, made in the common way with wheat flour, water, salt and yeast. This proportion is practically a maximum, as bread made with more than fifty-nine per cent potatoes loses its consistency. It is even better to add only to the wheat dough not more than half of its weight of mashed potatoes.

When the dough has raised, the loaves are placed in the oven, which must not



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be so hot as for ordinary bread. The time of cooking must be a little longer; cooked as ordinary bread is, the potato wheat loaves of bread would have the crust too hard and the soft part too wet.

Potato bread may be baked in the same way with barley flour or rye flour instead of wheat. All varieties have good taste, with a special little hazel nut flavor, and they can be kept a longer time than the cereal bread.

Red beets are utilized too, in the making of bread, the roots being grated after having been cooked in water. The grated stuff is kneaded with its weight of flour, the mixture being treated with salt and yeast as ordinary dough, and cooked in the same way. The bread so prepared has an unusual flavor quite agreeable to the taste, and is better after two or three days of conservation. Instead of beets, apples or pears may be used, but the bread produced is not so cheap as the beet bread.

A Japanese bread is manufactured by the quartermaster bakeries with wheat and rice flours, sugar and fat, but the French soldiers did not care for it.

Some trials were made to suppress the making of flour: in this way, the expenses of the mill would be saved, and all wheat products used in the human alimentation. To manufacture the whole grain bread, after being washed in water, the wheat is placed in a large shallow pond with just enough water to soak it, and is left for 48 hours, at the end of which time it begins to germinate. Then the mass is immediately crushed and the dough molded into cakes, The bread is finally placed in the oven and baked in the usual way. But this method did not prove to be practicable because when bran and other like mill by-products are not used to feed animals, the farmers must cultivate forage instead of cereals. Besides, the bread made in this way did not please the French.

How the German Meets the Tank Attack

OUTWARDLY, the German ridicules the tank idea. But there are ample indications that down in his heart he entertains a considerable fear for the steel monster which has a habit of coming upon him suddenly and crushing down his defenses while remaining immune to his machine-gun fire. Perhaps, the best proof of what the Hun really thinks of the tank is the following translation of a general order captured from the group of armies of Caudry, in France:

"Obstacles: Trenches of a minimum width of from 13 to 16½ feet and a depth of at least 10 feet, also a very thick mud, constitute very serious obstacles against tanks. Freshly plowed land or barricades are easily crossed.

"It is not worth while constructing obstacles; it is preferable to attack.

"Methods of attack: Tanks on the march should be attacked by artillery before their entry into action, even if there is not a great chance of hitting them. The essential thing is to forbid the enemy infantry to follow them; it is necessary that the enemy infantrymen fear the zone over which the tanks are advancing.

"To attack the tanks themselves the only reasonable method is to place the cannon in the advanced zone of the battlefield so that they may be able immediately to put the tanks out of action by direct hits. Every shot which hits the mark kills several men of the crew and often sets fire to the tank. The artillery sections which are held in reserve back of the front do not know what is going on, and in general arrive too late to be of use.

"The cannon, in principle, should be placed far in advance; thus the enemy is not able to surprise us.

"The commander of the front line troops should be responsible for the placing of anti-tank cannon. Pieces mounted on auto trucks are very useful if the roads are good.

"Infantry: The line of battle must not be opened, except to allow intact tanks to pass; the troops may seek cover, but they would not fall back. It is necessary that the tanks should be put out of action back of the line. The main thing is to repulse the enemy infantry. Several posts should be detached behind the front for the defense against the tanks.

"Armament: The most efficacious weapon against the tanks is the armor-piercing bullet. It is feared by the crews of the tanks, because it pierces the armor and produces at the same a great flame, which frequently sets fire to the fuel reservoir.

"The best method of attacking a tank is from the rear, because it is not easy for its crew to fire from behind, and because the rear is the part the least protected. Street fighting against the tanks is very favorable to the infantry; the troops shelter themselves in the houses and let the tanks pass, and then open fire with machine guns and rifles from close range.

"Hand grenades, employed one at a time, are useless. It is necessary to employ a concentrated charge (several cylinders grouped around a central grenade), and throw it under the tank; but this is not easy to do.

"Light trench cannon (minnenwerfer) are efficacious, when they are fired from a feeble angle; good results have been obtained by the fire of isolated pieces.

"In general, the tactics to employ against tanks must be made the object of theories and practical experience; the tanks will thus lose their terrifying effect."

Improved Electric Welding

ELECTRIC welding has two principal applications, the arc and resistance processes respectively, spot welding being a special modification of the latter applied to sheet work. These applications are well known in practice, but they are unsuitable for complicated work or for sections of irregular profile. For such work the so-called fusion process is recommended by a German paper, the *Elektrotechnische Zeitschrift*. According to this process, the two pieces to be welded are brought sufficiently close to strike a series of arcs between them. The pieces are then gradually drawn together, so that the whole welding area appears to be enveloped in a shower of sparks, the sections being thus gradually melted in an even manner over the whole area to be welded. The current is then switched off, and the two pieces are pressed together and united. The advantages claimed for this process are that the ends to be welded need not be carefully trimmed beforehand, since irregularities are melted away in the process, and further only a small ridge is formed at the weld. It is preferable to trim this level with a chisel while it is still red hot, but to avoid forcing the pressed-out portion into the welded seam it should not be hammered, as in ordinary butt welding. The strength of welds made by this process is claimed to be 98 per cent of that of the unwelded material, and the process can be successfully applied for welding tube strips or similar material, and especially for welding tool-steel cutting ends to ordinary iron or steel holders. In such cases, and for all large sections, it is advisable to bring the pieces to a red heat by using the current as in ordinary butt welding forcibly separating them if necessary with the current switched off before starting the fusing process.

Germany's Great Progress in Nitrogen Fixation from the Air

GERMANY has made wonderful progress since the war started in converting the nitrogen of the air into certain compounds and this has been her only salvation in sustaining her ability to make nitric acid for high explosives. According to reliable information, the production of ammonia in Germany by the fixation of nitrogen from the air by the Haber synthetic process rose from 30,000 tons in 1913, to 60,000 tons in 1914, to 150,000 tons in 1915, and to 300,000 tons (estimated) in 1916. An output of 500,000 tons of ammonia was anticipated for 1917 containing 100,000 tons of nitrogen; at the same time 700,000 tons of sulfate of ammonia (140,000 tons of nitrogen) and 400,000 tons of calcium nitrate (80,000 tons of nitrogen) were expected to be produced, the total containing 320,000 tons of nitrogen. This exceeds by 100,000 tons the entire consumption of nitrogen in Germany in 1913.

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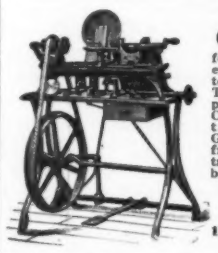

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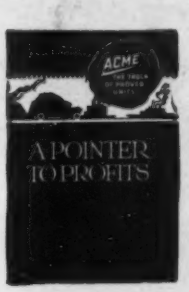

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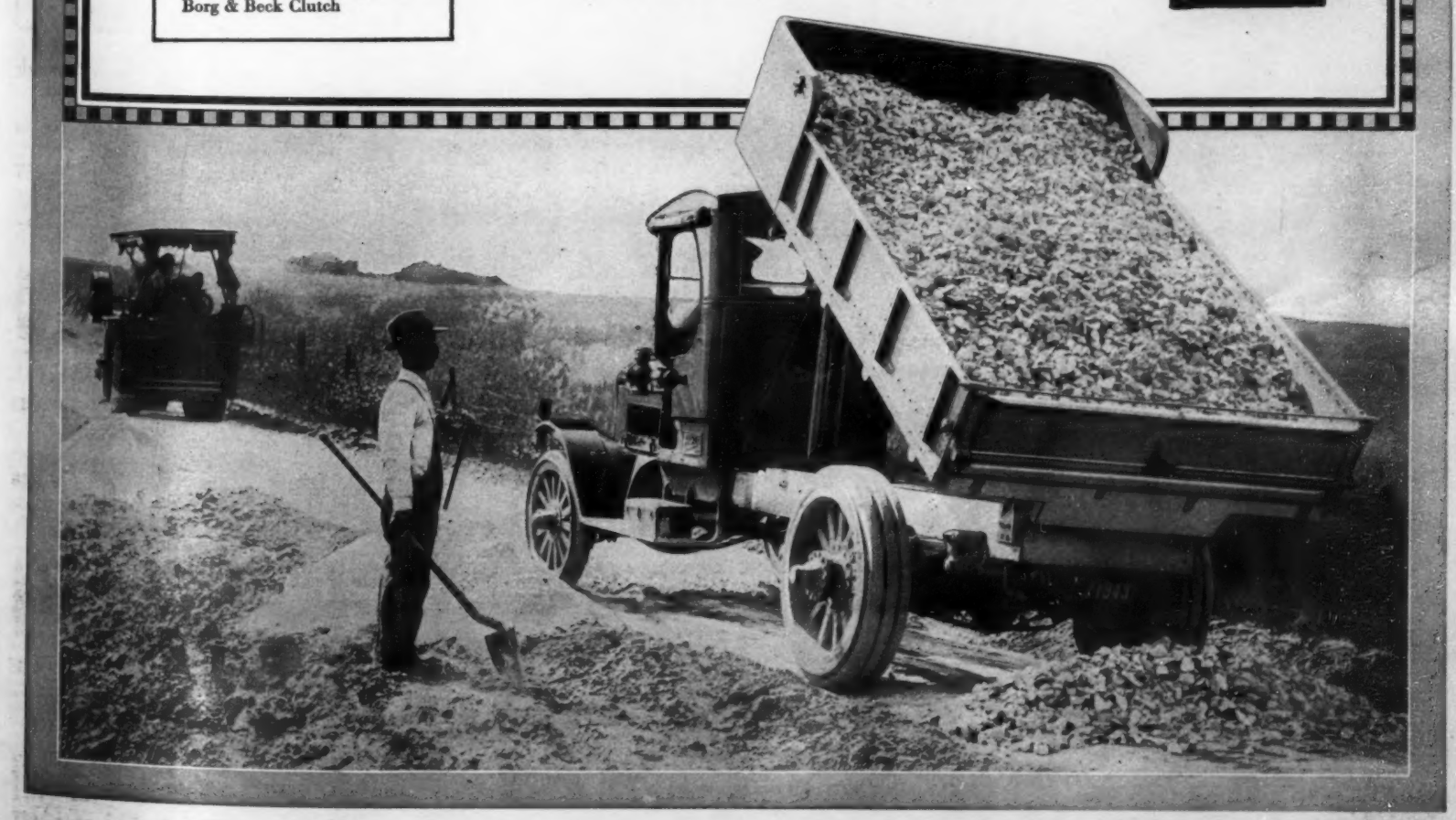

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